Department for Transport

Carbon and Sustainability Reporting Within the Renewable Transport Fuel Obligation

Requirements and Guidance

Draft Government Recommendation to RTFO Administrator

June 2007

Part One

Carbon and Sustainability Reporting Within the Renewable Transport Fuel Obligation

This document is the outcome of two projects conducted by independent consultants to advise Government on its policy decisions. It now forms the Government's draft recommendation to the Renewable Transport Fuel Obligation (RTFO) Administrator on how Carbon and Sustainability reporting should operate. The RTFO Administrator as an independent body will have the final say on how the process should work and will in due course decide what reporting requirements to introduce. The Government will issue a summary of responses after this consultation period ends which will include a final recommendation to the RTFO Administrator on how Carbon and Sustainability reporting should operate under the RTFO scheme.

This document should be read in conjunction with the Regulatory Impact Assessment on the draft RTFO Order and the Carbon methodology and Sustainability framework reports written by the consultants which describe the principles behind this document. These are available at www.dft.gov.uk/roads/RTFO

The Government is grateful to the Low Carbon Vehicle Partnership who have managed this work and to the E4tech and Ecofys consultants whose advice has led to this document.

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Foreword

Consultation on the Government's proposed draft Requirements and Guidance for Carbon and Sustainability Reporting under the Renewable Transport Fuel Obligation (RTFO).

As set out in the Government's earlier consultation on the detailed design of the RTFO (available at http://www.dft.gov.uk/consultations/open/draftrtfo/), it is proposed that in order to receive RTF certificates, transport fuel suppliers will have to provide the RTFO Administrator with information on the carbon savings and the wider sustainability impacts of the biofuels they have supplied.

This consultation seeks your views on draft requirements and guidance for carbon and sustainability reporting within the RTFO scheme. We would particularly welcome comments on the following points:

1. Is the general scope of the reporting requirement set out in chapter 2 appropriate?
2. Is the meta standard approach suggested in chapter 3 appropriate?
3. Are the Environmental and Social principles set out in chapter 3 the right ones?
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Further copies of this consultation and the associated documents are available at www.dft.gov.uk/roads/rtfo

The final version of this document will form the Government's recommendations to the RTFO Administrator on how Carbon and Sustainability reporting under the RTFO could operate. The Administrator as an independent body will make the final decision on how the process should work and the detail of the reporting requirements.

1. Background

The Government commissioned two projects by independent consultants and managed by the Low Carbon Vehicle Partnership[1] to demonstrate how Carbon and Sustainability (C & S) reporting could work under the RTFO. The aim was to develop

- a practical methodology for the quantification of the greenhouse gas savings offered by different biofuels; and
- instructions and guidance to enable suppliers both to apply the methodology effectively and to report on the environmental and social aspects of biofuels being supplied to the UK market.

The draft Requirements and Guidance (available at http://www.dft.gov.uk/roads/rtfo) is the primary output of this work. Its development has been overseen by two advisory groups representing a broad range of key stakeholders. The Requirements and Guidance for Carbon and Sustainability reporting specifies the format and scope of the information transport fuel suppliers would be required to provide in their monthly and annual reports.

Part two of this document (Carbon reporting – default values and fuel chains) explains in detail how the default values would be applied and how they have been calculated.

Additional documents that summarise the principles behind the Requirements and Guidance are also available at the same website and comprise:

a) *Sustainability reporting within the RTFO: Framework report* This document, written by Ecofys, describes the principles behind the reporting requirements for environmental and social issues.

b) *Carbon reporting within the RTFO: Methodology* This document, written by E4tech, provides the principles behind the carbon calculation methodology.

c) *RTFO Partial Regulatory Impact Assessment:* This RIA for the draft RTFO order contains estimates of the costs of complying with the reporting requirement. Comments on the costs would be welcome.

1 The Low Carbon Vehicle Partnership is an action and advisory group, established in 2003 to take a lead in accelerating the shift to low carbon vehicles and fuels in the UK and to help ensure that UK business can benefit from that shift.

2. How to respond

This consultation began on 21st June 2007 and ends on 13th September 2007. Please send comments using the response form in Annex K to the RTFO Team at

Department for Transport
Zone 2/21 Great Minster House
76 Marsham Street

London SW1P 4DR
E-mail: rtfo.consultation@dft.gsi.gov.uk

If you have any questions about the guidance please contact Rupert Furness at Rupert.Furness@dft.gsi.gov.uk

When providing comments, it would be very useful if you could state whether you are responding as an individual or representing the views of an organisation.

This consultation has been produced in accordance with the principles of the Government's "Code of Practice on Consultation" which are included at Annex I.

According to the requirements of the Freedom of Information Act (2000), all information contained in your response to this consultation may be subject to publication or disclosure. This may include personal information such as your name and address. If you want your response or your name and address to remain confidential, you should explain why confidentiality is necessary. Your request will be granted only if it is it is consistent with Freedom of Information obligations. An automatic confidentiality disclaimer generated by your e-mail system will not be regarded as binding on the Department.

3. Next steps

This consultation is being conducted in parallel with a piloting exercise under which a number of transport fuel suppliers will test the practical application of the requirements and guidance. The comments received will be evaluated in conjunction with the results from the pilot, and will be used to develop the final version of the requirements and guidance.

The final version of this document will form the Government's recommendations to the RTFO Administrator on how Carbon and Sustainability reporting under the RTFO scheme should operate. The Government will publish a summary of the responses received from the Consultation with its recommendations to the RTFO Administrator after this consultation period has ended. The Administrator as an independent body will make the final decision on how the process should work and the detail of the reporting requirements.

A summary of responses to this consultation will be published on our website www.dft.gv.u,uk after the consultation period has closed.

Part 1
Executive Summary

The Renewable Transport Fuel Obligation (RTFO) is due to be one of the Government's main policies for reducing greenhouse gas emissions from road transport. It is intended to deliver carbon savings of around 1 million tonnes per annum by 2010, roughly equivalent to removing 1 million cars from the road, by encouraging the supply of renewable fuels.

The greenhouse gas (GHG) and sustainability impacts of different biofuels vary significantly. The GHG benefits of biofuels depend, among other things, on the system of cultivation, processing and transportation of feedstock. The introduction of biofuels can also lead to unintended negative environmental and social impacts.

Maintaining public confidence in biofuels requires Government and the biofuels industry to find effective ways to manage the potential negative impacts of their increased demand.

To encourage suppliers to source sustainable biofuels the Government proposes that the Administrator of the RTFO scheme will require biofuel suppliers to submit reports on both the net GHG saving and the sustainability of the biofuels they supply, in order to receive Renewable Transport Fuel Certificates (RTFCs). This consultation seeks views on the carbon and sustainability (C&S) reporting requirements that the Government has commissioned through the Low Carbon Vehicle Partnership for the RTFO scheme.

This consultation complements and should be read in conjunction with the Government's consultation on the draft RTFO Order which is available at

http://www.dft.gov.uk/roads/rtfo.

A Reporting Scheme

The Government proposed in the consultation on the draft RTFO Order to develop a reporting framework to encourage the supply of biofuels that do not have a negative impact on the environment. Reporting is seen as a 'stepping-stone' towards a mandatory assurance scheme that would reward biofuels based upon their carbon intensity and penalise those that came from feedstocks produced unsustainably. This first step is necessary due to the currently limited availability of data and the need to test the robustness of the criteria and methodology, in the absence of comprehensive internationally agreed standards. There are also concerns that the unilateral adoption by the UK of a mandatory assurance scheme at this early stage could give rise to WTO issues.

It is proposed that "not known" reports will, at least initially, be permissible in recognition that it may be difficult to provide information for some fuels sourced from overseas – particularly those purchased on the spot market. It is proposed that annual, independently verified reports of overall supplier performance will be required from suppliers applying for certificates. These will demonstrate their performance in sourcing sustainable biofuels with good GHG savings[2].

It is proposed that the Secretary of State will set targets for three key aspects of the reporting scheme. The targets will not be mandatory but will illustrate the level of performance which the Government expects from fuel suppliers. Suppliers will be encouraged to strive to meet these targets but no penalties will be issued for failing to meet them.

Annual supplier target	2008-2009	2009-2010	2010-2011
Percentage of feedstock meeting a Qualifying Standard	–	50%	80%
Annual GHG saving of fuel supplied	40%	50%	60%
Data reporting of sustainability characteristics	35%	65%	80%

The Secretary of State will keep these targets under review and will give notice of any modifications.

It is proposed that the Administrator will publish reports of individual supplier performance in the areas of carbon intensity and sustainability on an annual basis and possibly more frequently. The Administrator may also choose to make available other information on the environmental impact of the RTFO including information from annual and monthly C&S reports that identifies individual suppliers. It is intended that this reporting process will make information available in a way that is accessible to consumers and which could inform their purchasing decisions.

Subject to the relevant freedom of information laws, individual suppliers' volume information will however not be made public, nor any information from which individual supplies market shares can be deduced. Aggregated information may be made publicly available.

Reporting Requirements

It is proposed that obligated suppliers who wish to claim RTFCs will be required to submit monthly and (if they apply for 450,000 or more certificates in an obligation period) annual C&S reports. The monthly reports are expected to be required by the

2 It is proposed that suppliers claiming fewer than 450,000 RTFCs in an obligation period will not need to submit an annual report.

15th day of the month following the month in which the fuel was supplied. This would mean that, for example, reports for the period 15 June 2008 to 14 July 2008 (inclusive) would be due by 15 August 2008. Non obligated suppliers will be required to report whenever they wish to claim RTFCs.

Under the RTFO Order the obligation period ends on 14th April of 2009 and each subsequent year. It is expected that the Administrator will require annual reports by 30th September in the same year and that these will have to be accompanied by a verifier's statement. The annual report will not be linked to the issuing of certificates, but failure to submit an annual report is in breach of a requirement which may incur a civil penalty.

Monthly reports

As explained above, it is proposed that obligated suppliers should be required to report monthly on the fuels they have supplied, and that non-obligated suppliers should be required to report whenever they wish to receive RTFCs for the fuel they supply. The term "monthly reporting" is used throughout this document to differentiate these reports from annual reports.

It is proposed that monthly reports should list the "administrative batches" of feedstock or fuel. An "administrative batch" is one with homogenous sustainability characteristics. For example, three tanker movements of fuel with identical sustainability characteristics (e.g. palm oil from Malaysia meeting the requirements of the Round Table on Sustainable Palm Oil (RSPO)) could be reported as a single batch. But a separate tanker movement of palm oil from Malaysia without any form of assurance would have to be reported as a different batch to the ones above, as its sustainability characteristics would be different.

Annual Reports

It is proposed that Annual Reports should contain aggregate monthly information and in addition details of:

- Actions that have been taken to increase the sourcing of sustainable biofuels and biofuels with a lower carbon intensity, including actions to promote production on idle land
- Environmental management system certificates
- Existing verified environmental / corporate responsibility reporting.

Table A: Monthly reporting format

Batch number	Fuel type	Quantity of fuel (litres or kg[1])	Biofuel Feedstock	Feedstock Origin	Sustainability Information			Carbon Information		
					Env. Standard	Social Standard	Land use in Nov 2005	Carbon intensity (g CO_2e / MJ)	Impact of LUC (g CO_2e / MJ)	Accuracy level
33001	Bioethanol	250,000	Wheat	UK	LEAF	Mechanised + LEAF	Cropland	72	0	2
33002	Bioethanol	100,000	Wheat	France	-	Mechanised	Cropland	76	0	2
33003	Bioethanol	250,000	Sugar beet	UK	ACCS	Mechanised	Cropland	45	0	4
33004	Bioethanol	1,000,000	Sugar cane	Brazil	-	-	Cropland	19	0	2
33005	Bioethanol	500,000	Unknown	Unknown	-	-	Unknown	72	Unknown	0
33006	Biodiesel	1,000,000	Oilseed rape	UK	ACCS	Mechanised + RTFO	Cropland	79	0	2
33007	Biodiesel	250,000	Oilseed rape	Unknown	-	Mechanised	Unknown	79	0	2
33008	Biodiesel	500,000	Palm oil	Malaysia	RSPO + RTFO	RSPO + RTFO	Cropland	49	Unknown	2
33009	Biomethane	150,000	Dry manure	UK	By-product	By-product	By-product	36	0	2
33010	Bio-ETBE	500,000	Wheat	UK	LEAF	Mechanised + LEAF	Cropland	12	0	2

[1] biogas should be reported in kg and liquid fuels in litres

Scope and Principles for RTFO C&S Reporting

Greenhouse Gas Calculation Methodology

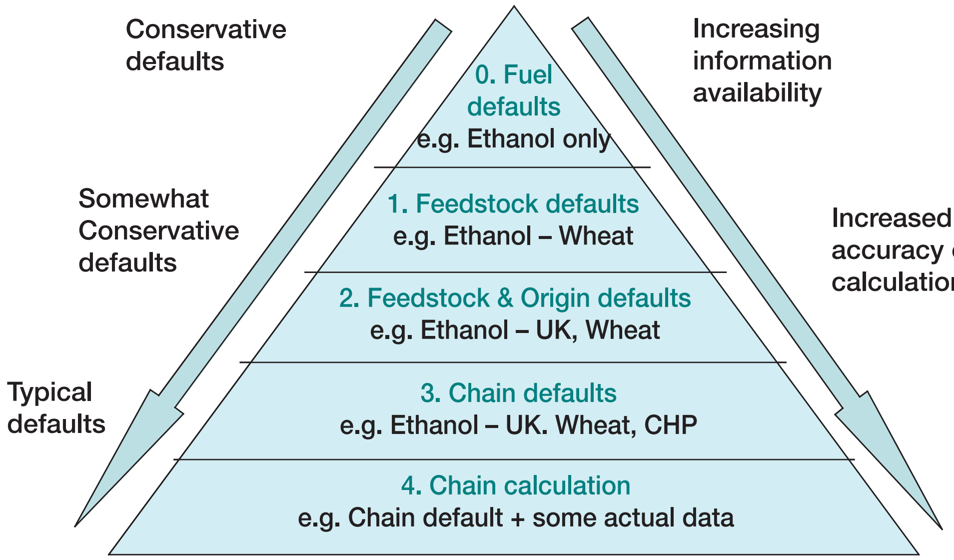
The methodology is based on a well-to-wheel calculation that includes all significant sources of GHG emissions. This enables direct comparison of fuel chain GHG saving on a like for like basis. Detailed calculations have been made for the principal feedstocks expected to supply biofuel to the UK at the start of the RTFO scheme:

- Ethanol from: sugar cane, sugar beet, wheat and corn
- Ethanol converted to ETBE
- FAME biodiesel from: tallow, used cooking oil, palm oil, soy and rapeseed
- Biomethane from anaerobic digestion of MSW and manure.

The guidance covers all biofuels currently covered by the scheme and the main feedstocks for their production. The Government is likely to extend the RTFO order to other biofuels if they are introduced into the UK market on a significant scale. It is also possible that new feedstocks or production pathways come available for existing biofuels covered by the scheme. In these circumstances, new calculations and default values will need to be developed. The draft Requirements and Guidance provides instructions for fuel chains not currently defined.

The calculation methodology uses default values that provide estimates of the carbon intensity of different fuel chains. It enables suppliers with specific information about their supply chain to supply additional qualitative or quantitative data to improve the accuracy of the calculation. The scheme is designed to encourage better reporting of data by applying more conservative GHG savings to high level default values (where little is known about the origin of the supply chain); but typical default factors where the calculation includes more detailed information. This is illustrated at Figure 1. This flexible calculation method provides a practical, cost-effective and credible reporting system. It is proposed that suppliers will also be required to report on the amount of real information used in their calculations as opposed to using default values or reporting that they do not know the origin of their fuel.

Figure 1: Hierarchy of default values used



Where information on previous land use has been supplied, the calculation includes the effect on overall GHG savings. Default values for specific land use changes are based on Intergovernmental Panel on Climate Change guidelines. Where information is not provided, the calculation does not include any land-use change carbon impacts. Instead, it is proposed that the Administrator should conduct an *ex post facto* analysis of the potential emissions associated with 'unknown' land use changes.

Sustainability Reporting

The principal environmental and social risks arising from biofuel production (such as deforestation and loss of biodiversity) arise at the plantation. The sustainability reporting therefore focuses on this part of the supply chain. It is proposed that a future evolution of the scheme would encompass the wider supply chain including processing and transportation of feedstock.

The sustainability reporting model makes use of existing voluntary agri-environment and social accountability schemes to minimise the cost and administrative burden of compliance. These existing standards have been benchmarked against an RTFO Sustainable Biofuel Meta-Standard. This has seven principles identified in Table B and includes a number of criteria and indicators to assess the extent to which the feedstock produced in accordance with each scheme can be considered sustainable.

Table B: Environmental and social principles

Environmental principles
1. Biomass production will not destroy or damage large above or below ground carbon stocks
2. Biomass production will not lead to the destruction or damage to high biodiversity areas
3. Biomass production does not lead to soil degradation
4. Biomass production does not lead to the contamination or depletion of water sources
5. Biomass production does not lead to air pollution
Social principles
6. Biomass production does not adversely affect workers rights and working relationships
7. Biomass production does not adversely affect existing land rights and community relations

We recognise that there are some wider environmental and social principles that are difficult to monitor at the fuel supplier level (including, competition with food prices, not removing economic possibilities for developing nations). Therefore it is proposed that the Administrator will monitor these principles ex post.

A comprehensive range of existing standards have been benchmarked as illustrated in Table C. Additional standards can be benchmarked by the Administrator as they become available. Suppliers will be able to report whether their feedstock meets a standard that has been benchmarked against the Meta-Standard. Benchmarked standards that meet the required level of sustainability are called Qualifying Standards.

Under the proposed model, suppliers will also be able to organise additional supplementary checks to demonstrate that feedstock complies fully with the Meta-Standard criteria.

Table C: Benchmarked and Qualifying Standards

Standard	Qualifying Environmental Standard?	Qualifying Social Standard?
Linking Environment and Farming Marque	Yes	No
Roundtable on Sustainable Palm Oil	Yes	Yes
Sustainable Agriculture Network/ Rainforest Alliance	Yes	Yes
Basel Criteria	Yes	Yes
Forest Stewardship Council	Yes	No
Social Accountability 8000	No	Yes
Assured Combinable Crops Scheme[3]	No	No
EurepGAP IFA	No	No
International Federation of Organic Agriculture Movements	No	No

To minimise the burden on business, it is not proposed to require suppliers to report on criteria where the risk of adverse impacts is minimal. In developing these principles objective, risk-based metrics have been used. The following rules apply:

a) Where a feedstock represents less than 10% of the farm gate value

The biofuel producer purchasing these by-products will have little influence on the sustainability of the production process for the original product. For example, a biofuel producer buying tallow will have little or no influence on the standards applied to rearing the cattle. Used cooking oil, tallow, municipal solid waste and manure currently fall into this category and the model does not require suppliers to report on environmental and social standards and land use in respect of these biofuels. For these feedstocks suppliers may enter ‘by-product’ into these columns within the monthly reports. Reporting carbon intensity would be required and can be derived using the GHG calculation methodology.

b) Where a feedstock is grown with a labour intensity of less than 5 man days/hectare

Highly mechanised feedstock production poses considerably different risks to the working conditions of labourers than feedstock grown under labour intensive conditions. It is therefore proposed that suppliers of biofuels from feedstocks produced in highly mechanised processes (less than 5 man days/ hectare) may enter ‘mechanised’ into the social standard column within the monthly standard reports. It is proposed that the Administrator should produce a list of those feedstocks which can

3 ACCS is not currently a Qualifying Standard Scheme but may shortly be revised to include additional criteria that would meet all requirements for a Qualifying Standard.

be treated in this way, and that the list should initially comprise soy, sugar beet, wheat, maize and rape. The Administrator will keep this list under review. It is proposed that reports on the principle of land rights should be required for all feedstocks, whether highly mechanised or not.

Verification

To validate the accuracy of C&S reports a chain of custody must be established from the feedstock producer to the fuel supplier. Where the existing assurance scheme does not operate its own chain of custody the RTFO C&S reporting model operates a "mass balance" approach. This requires suppliers in the supply chain to account for their product on a "units in – units out" basis but does not require physical separation of certified feedstock or fuel from uncertified feedstock. This ensures that for every unit of sustainable biofuel sold the corresponding feedstock entered the market.

The model requires suppliers throughout the chain to keep input and output records of the feedstock characteristics entering and leaving the plant or process stage. The feedstock or fuel sold will have its carbon and sustainability characteristics described on an invoice or related document.

It is proposed that the reliability of claims made in annual C&S reports should be demonstrated through an independent verification (or assurance engagement) that must be completed by the 30th September. Initially, it is considered that assurance engagements should aim to provide at least 'moderate' assurance (from a limited assurance engagement). It is proposed that suppliers engage auditors who are qualified to carry out audits against the International Standard on Assurance Engagements (ISAE 3000), which defines requirements for limited-scope engagements. It is likely that the verifier's statement, with the annual report, will be made available on the Administrator's website.

2. Introduction

2.1. Context

The UK's Renewable Transport Fuel Obligation (RTFO) is due to commence on 15 April 2008. It is intended to deliver carbon savings of around 1 million tonnes per annum by 2010, roughly equivalent to removing 1 million cars from the road, by encouraging the supply of renewable fuels.

When introduced by an Order under the Energy Act 2004, it will impose a legal obligation on suppliers of fossil fuel for road transport ("obligated suppliers") to produce Renewable Transport Fuel Certificates (RTFCs) showing that an amount of renewable fuel has been supplied which is equivalent to a specified percentage of their total fuel sales. The certificates can be earned from their own sales of renewable fuels, or can be acquired from other suppliers of renewable fuels. Alternatively, obligated suppliers can "buy out" of their obligation by paying a buy-out price to the RTFO Administrator. Suppliers of biofuels who are not obligated suppliers will also be able to apply for RTFCs.

The greenhouse gas (GHG) and sustainability impacts of different biofuels vary significantly. The GHG benefits of biofuels depend, among other things, on the system of cultivation, processing and transportation of feedstock. The introduction of biofuels can also lead to unintended negative environmental and social impacts. Key issues include potential competition with food crops leading to increased commodity prices. Increased pressure for land may lead directly to deforestation to make way for new plantations with biodiversity impacts and loss of carbon stocks that negate any GHG savings. Changes in land use may also occur indirectly where existing agricultural activities are displaced into forest land by crops for energy.

Some biofuels production has also been associated with social concerns including labour rights, land conflicts and health concerns related to improper use of agrochemicals. Biofuel demand can also create economic benefits, however, including employment opportunities.

Maintaining public confidence in biofuels requires Government and the biofuels industry to find effective ways to manage potential negative impacts of their increased demand. Most risks can be managed by suppliers through effective assurance schemes that demonstrate biofuels are sourced sustainably. Competition with food and indirect land use changes can be managed by national governments and international bodies through other policy mechanisms.

The Government wishes to avoid as far as possible any negative environmental and sustainability consequences which could arise from the promotion of biofuels and to encourage the supply of fuels with the lowest carbon intensities. Accordingly, the Government proposes that the Administrator of the RTFO should require fuel suppliers to submit reports on the carbon and sustainability characteristics of the fuels they have supplied in order to receive Renewable Transport Fuel Certificates (RTFCs).

It is proposed that, at least in the early years of the RTFO, it will be legitimate for suppliers to report that they do not know the provenance or sustainability impacts of some or all of their biofuels. This is to take account of the fact that, in what will be a very new market, detailed information will not always be available on the precise origins of the biofuel feedstock. The Government intends, however, to set targets for suppliers' performance in a number of areas, to give an indication of the level of performance that is expected. For further details, see chapter 4.

The information provided by suppliers will be used by the RTFO Administrator to report annually to the Secretary of State and Parliament on the RTFO, including its environmental and sustainability effects.

This document constitutes the Government's draft recommendations to the RTFO Administrator as to how Carbon and Sustainability reporting should operate under the RTFO. Final decisions on reporting requirements will be a matter for the RTFO Administrator.

2.2. Relevant background documents

Part two of this document (Carbon reporting – default values and fuel chains) explains in detail how the default values would be applied and how they have been calculated.

This document does not provide a detailed description of the methodologies underpinning the carbon and sustainability reporting recommendations. Further information is available in the following background documents produced by Ecofys and E4tech respectively which are available at www.dft.gov.uk/roads/RTFO

- *Sustainability reporting within the RTFO: Framework report.*
- *Carbon reporting within the RTFO: Methodology*

This document should also be read in conjunction with other documents which explain how the RTFO operates, including the Consultation on the Draft RTFO Order and the associated Partial Regulatory Impact Assessment, available via the DfT website at http://www.dft.gov.uk/roads/rtfo .

3. Monthly reporting

The Government proposes that the Administrator of the RTFO scheme will require obligated suppliers to provide carbon and sustainability information on a monthly basis and other fuel suppliers to provide this information at any time they wish to claim RTFCs. For simplicity, the process is referred to as "monthly" reporting throughout this chapter to distinguish it from annual reporting.

This chapter sets out the proposed requirements for monthly carbon and sustainability reporting by fuel suppliers to the RTFO Administrator. It illustrates the proposed format for monthly reporting that will be required by the RTFO Administrator and describes how monthly reporting relates to the issuing of RTFCs by the Administrator. This chapter is of particular interest to obligated suppliers and any other fuel suppliers who wish to claim RTFCs. It is proposed that every application for a certificate must be supported by a C&S report and where some or all of the data is not known, this must be stated in the report. Where information is known this must be provided within reports. Where information becomes available after the report is made which renders the report inaccurate, the supplier must inform the RTFO Administrator. It is proposed that some data requirements will not be applicable to certain feedstocks and recommended instructions are provided on reporting in these cases.

The detail of the proposal is set out below.

3.1. Reporting requirements

If an obligated supplier wishes to apply for RTFCs for a particular month, it must submit a C&S report covering the same period as its volume report for that month. Non-obligated suppliers are required to report whenever they wish to apply for certificates.

3.2. Introduction to monthly sustainability reporting

Monthly sustainability reporting refers to the sustainability of feedstock production and makes use of existing voluntary agri-environment and social accountability schemes.

For the RTFO two levels of sustainability are recognised:

- The 'RTFO Sustainable Biofuel Meta-Standard'.
- The Qualifying Standard.

The RTFO Sustainable Biofuel Meta-Standard

The 'RTFO Sustainable Biofuel Meta-Standard' consists of 7 sustainability principles, see Table 1. Each principle consists of one or more criteria and each criterion consists of one or more indicators. All criteria and indicators for the RTFO Sustainable Biofuel Meta-Standard are included in Annex B. Existing standards have been benchmarked against the RTFO Sustainable Biofuel Meta-Standard and where all of these criteria are met, the standard is equivalent to the RTFO Sustainable Biofuels Meta-Standard.

Table 1 – RTFO sustainability principles. Full criteria and indicators are included in Annex B.

Environmental principles	
Principle 1	Biomass production will not destroy or damage large above or below ground carbon stocks
Principle 2	Biomass production will not lead to the destruction or damage of high biodiversity areas
Principle 3	Biomass production does not lead to soil degradation
Principle 4	Biomass production does not lead to the contamination or depletion of water sources
Principle 5	Biomass production does not lead to air pollution
Social principles	
Principle 6	Biomass production does not adversely affect workers rights and labour conditions
Principle 7	Biomass production does not adversely affect land rights and community relations

We recognise that there are some wider environmental and social principles that are difficult to monitor at the fuel supplier level (including, competition with food prices, not removing economic possibilities for developing nations). Therefore it is proposed that the Administrator will monitor these principles ex post.

The Qualifying Standard

Existing standards which meet most, but not all, of the RTFO sustainability criteria underlying the principles above are accepted as proof of an acceptable level of sustainability. These standards are called *Qualifying Standards*.

Several existing standards only address either environmental issues or social issues therefore the Qualifying Standard is defined separately for environmental and social criteria. If the existing standard sufficiently addresses both environmental and social criteria it can be an environmental Qualifying Standard *and* a social Qualifying Standard.

The RTFO Sustainable Biofuel Meta-Standard criteria which are not fully met by a Qualifying Standard are called '*gap criteria'.* Supplementary checks can be performed to address these gap criteria and therefore meet the level of the RTFO Sustainable Biofuels Meta-Standard (see Annex A). Supplementary checks may only be performed by auditors accredited for the standard to which the gap criteria apply.

Further Guidance

For guidance on environmental and social sustainability standards, see Annex A. This Annex describes the selection of standards benchmarked and provides guidance on the procedure for benchmarking additional standards. It also describes the requirements for claiming a certain sustainability standard and in which situations part(s) of the sustainability requirements are not applicable.

For a full list of criteria and indicators of the RTFO Sustainable Biofuel Meta-Standard, see Annex B.

A detailed overview of the benchmark results of those standards already benchmarked is provided in Annex C. This Annex also illustrates the gap criteria for each benchmarked standard. Gap criteria for Qualifying Standards can be addressed through supplementary checks to reach the RTFO Sustainable Biofuels Meta-Standard.

3.3. What to report on?

Monthly reports should contain the following information (summarised in Table 2):

General batch information

- Administrative batch number: Each batch number will be unique. The batch refers to an administrative batch, not necessarily a physical batch. See Chapter 4 for the definition of an administrative batch.
- Volume of fuel: expressed in litres for liquid fuel or kg in the case of gas.
- Fuel type: indicating the fuel type: biodiesel, bioethanol, biomethane or bio-ETBE.
- Feedstock: the feedstock type from which the fuel is made.
- Feedstock origin: the country of origin of the feedstock.

Sustainability information for each administrative batch

- Environmental standard: suppliers can report any standard benchmarked against the RTFO Sustainable Biofuel Meta-Standard. The standard does not need to be a Qualifying Standard to be reported. However, the Government intends to set targets to indicate the proportion of biofuels which is expected to meet a Qualifying Standard (see Chapter 4).

  - For by-products[4], sustainability reporting is not required: fill in 'by-product'.
  - If supplementary checks are performed successfully on the gap criteria of Qualifying Standards the RTFO Sustainable Biofuel Meta-Standard can be reported. See example on page 26.
- Social standard: suppliers can report any standard benchmarked against the Sustainable Biofuel Meta-Standard. The standard does not need to be a Qualifying Standard to be reported. However, supplier targets will be set for the proportion of biofuels which is expected to meet a Qualifying Standard (see Chapter 3).
  - For by-products, sustainability reporting is not required: fill in 'by-product'.
  - For highly mechanised farming, reporting on labour conditions is not required, but reporting on land rights issues must be fully completed[5]. See example on page 20. If compliance with land rights criteria is not reported, the social standard is not fully complied with and does not count towards the indicative target.
  - If supplementary checks are performed on the gap-criteria the RTFO Sustainable Biofuel Meta-Standard can be reported. See example on page 20.
- Land use in November 2005,
  - For guidance on how to determine the Land use in November 2005, see Annex G
  - For by-products fill in: 'by-product'.

Carbon information for each administrative batch

- Carbon intensity expressed in g CO_2e / MJ.
- Impact of land use change expressed in g CO_2e / MJ.
- Accuracy level – a measure of what type of data was used to derive the carbon intensity of a batch of biofuel

3.4. Further guidance

- For guidance on assessing the carbon intensity of an administrative batch of biofuel see Annex F.
- For guidance on assessing the impact of land use change see Annex G.
- For guidance on assessing the accuracy level of an administrative batch see Annex H.

3.5. When to report?

Obligated suppliers are required to report on a monthly basis. Reporting months for obligated suppliers under the RTFO run from the 15th of a month until the 14th of the

4 For a definition of by-products see Annex A.

5 Land rights and community relations are captures under the criteria of principle 7 of the RTFO Sustainable Biofuel Meta-Standard, see Annex B.

following month. The report to the RTFO Administrator is expected to be required by the 15th of the month following the month of supply. This would mean that, for example, reports for the period 15 June 2008 to 14 July 2008 (inclusive) would be due by 15 August 2008. Non obligated fuel suppliers must provide a Carbon and Sustainability report whenever they wish to apply for RTF certificates.

Fuel suppliers will submit two reports to the RTFO Administrator: a volume report and a carbon and sustainability (C&S) report.

The volume report and C&S report can be submitted separately and at different times, provided both reports meet the deadline and that they cover the same period.

The volumes in the C&S report must match the volumes in the volume report.

Changing carbon and sustainability data after monthly reporting deadline

If new evidence about the C&S characteristics of a fuel emerges **after** a monthly report has been submitted suppliers must submit a "variance report" containing the new information and updating the previous record. This includes where a "don't know" has previously been declared and where new information becomes available meaning that the supplier does actually know the provenance of the fuel. A time limit may be imposed for the submission of variance reports to ensure that they are given before the relevant annual report.

A variance report must contain the same information as a monthly report (including in particular the administrative batch's unique identification number).

3.6. Reporting on purchased certificates

Suppliers do not have to report on the carbon and sustainability impacts of those biofuels in respect of which they have bought or acquired certificates from third parties. It is only the supplier which first applies for a certificate in respect of a fuel that must complete a carbon and sustainability report.

3.7. Publication

It is proposed that the Administrator should publish reports of individual supplier performance in the areas of carbon intensity and sustainability including a comparison with the targets (set out in table 5) on an annual basis and possibly more frequently. The Administrator may also choose to make available other information on the environmental impact of the RTFO including information from annual and monthly C&S reports which identifies individual suppliers.

Subject to the relevant freedom of information laws, individual suppliers' volume information however will not be made public nor any information from which volumes or market shares can be deduced. Aggregated information excluding fuel volumes used in annual reports may also be made publicly available.

Table 2 – Illustrative Monthly reporting requirement for carbon and sustainability data with example data

Batch number	Fuel type	Quantity of fuel (litres or kg[1])	Biofuel Feedstock	Feedstock Origin	Sustainability Information			Carbon Information		
					Env. Standard	Social Standard	Land use in Nov 2005	Carbon intensity	Impact of LUC	Accuracy level
								g CO_2e / MJ		
33001	Bioethanol	250,000	Wheat	UK	LEAF	Mechanised. + LEAF	Cropland	72	0	2
33002	Bioethanol	100,000	Wheat	France	-	Mechanised	Cropland	76	0	2
33003	Bioethanol	250,000	Sugar beet	UK	ACCS	Mechanised	Cropland	45	0	4
33004	Bioethanol	1,000,000	Sugar cane	Brazil	-	-	Cropland	19	0	2
33005	Bioethanol	500,000	Unknown	Unknown	-	-	Unknown	72	Unknown	0
33006	Biodiesel	1,000,000	Oilseed rape	UK	ACCS	Mechanised + RTFO	Cropland	79	0	2
33007	Biodiesel	250,000	Oilseed rape	Unknown	-	Mechanised	Unknown	79	0	2
33008	Biodiesel	500,000	Palm oil	Malaysia	RSPO + RTFO	RSPO + RTFO	Cropland	49	Unknown	2
33009	Biomethane	150,000	Dry manure	UK	By-product	By-product	By-product	36	0	2
33010	Bio-ETBE	500,000	Wheat	UK	LEAF	Mechanised + LEAF	Cropland	12	0	2

[1] biogas should be reported in kg and liquid fuels in litres

4. Annual reporting

The Government proposes that the Administrator of the RTFO scheme will require transport fuel suppliers to submit annual carbon and sustainability reports. This chapter sets out the proposed requirements for annual reporting, defines the information fuel suppliers may be expected to report on in their annual reports and provides details of proposed supplier targets. This chapter also describes how the RTFO Administrator may use the carbon and sustainability information provided.

Unlike monthly reports, annual C&S reports will not be linked to the issuing of RTFCs. However, annual reports are expected to be made publicly available by the Administrator and are proposed to be used to compare the carbon and sustainability performance of different fuel suppliers – both between suppliers and against the company targets.

The detail of the proposal is set out below:

4.1. Exemption

Suppliers claiming fewer than 450,000 certificates during an obligation period (1 year) will not be required to submit an annual report.

4.2. What to report on?

The core information in the annual report from the fuel supplier consists of the aggregated data from monthly reports over a single obligation period (April 15th to April 14th). This aggregated data must incorporate any changes that have been made by a supplier submitting a variance report. The annual report also requires fuel suppliers to provide additional information relevant to the sustainability and carbon intensity of their biofuels.

While the information detailed below is a requirement of annual reports, the structure as outlined below is not essential but is provided for guidance.

Chapter 1: Introduction. This chapter should include details of the supplier's policies and plans for improving its sourcing of sustainable biofuels with a lower carbon intensity.

Chapter 2: A summary of the sustainability characteristics of the fuel supplied. Aggregated monthly reporting data in the format illustrated in Table 3 and Table 4 must be supplied.

Chapter 3: This chapter should include information on the following items.

- Fuel supplier information:
  - Past year's and planned specific activities to improve proportion of sustainably sourced feedstock and reduce average carbon intensity
  - Past year's and planned activities to support standard development for sustainable biofuel feedstock (membership of RSPO, RTRS, BSI, etc)
  - Past year's and planned activities to promote feedstock production on idle land and, where possible, an indication of the volume of fuel originating from such idle land. While no universal definition of "idle land" exists a guideline to the interpretation of idle land for the purpose of the RTFO is given in Annex D[6].
  - Past year's and planned activities to improve the type of carbon data which is being used – e.g. the different default values or actual data.
  - Environmental management system certificates
  - Existing verified environmental / corporate responsibility reports
- Information on other parties within the supply chain:
  - Where fuel suppliers have information on their main crop producers[7], information should be provided on the percentage of that company's total production which meets respected sustainability standards[8].
  - Environmental management system certificates held e.g. ISO14001.

Suppliers are free to include additional information they deem relevant in their annual reports.

Chapter 4: Verification. The auditor's opinion must be included and the chapter may include any other details related to verification of the information provided in the report.

6 In the light of experience with sustainability and carbon reporting for the RTFO, the Administrator will assess the possibilities of including reporting on idle land in the monthly reporting process.

7 If it is wished not to disclose the identity of crop producers and intermediate processors, anonymous information can be reported. For example, for crop producers the percentage of total production which is produced according to respected sustainability standards can be reported without stating the identity of the supplier. The information has to be verifiable by the verifier but the identity will not be published.

8 In sourcing their feedstocks, fuel suppliers and biofuel producers should strive to give preference to crop producers who practise sustainability production on all their production units, instead of only on those production units which are used to supply the UK market.

Table 3 – Example data – Summary of feedstock mix, percentage of known reporting, percentage of feedstock which meets Qualifying Standards or the RTFO Sustainable Biofuel Meta-Standard and carbon intensity. Company targets are included in this table between brackets and are based on the targets for 2009/10.

Feedstock	General		Environmental		Social		Carbon	
	% Fuel supplied by feedstock type (by volume)[1]	% Data reported on sustainability characteristics[2]	%Meeting Qualified standard[3]	% Meeting RTFO Sustainable Biofuel Meta-Standard	% Meeting Qualifying Standard[3]	% Meeting RTFO Sustainable Biofuel Meta-Standard	Average carbon intensity g CO_2e/MJ	Average % GHG saving
Biodiesel								
Palm oil	10	30 (65)	50 (50)	10	50 (50)	15	51	41
Rapeseed oil	70	40 (65)	85 (50)	15	85 (50)	15	77	11
Soy oil	20	40 (65)	40 (50)	10	40 (50)	10	59	31
Bioethanol								
Sugar cane	20	20 (65)	10 (50)	10	10 (50)	10	20	76
Corn	10	30 (65)	70 (50)	30	70 (50)	30	62	27
Wheat	40	50 (65)	80 (50)	0	80 (50)	0	65	23
Sugar beet	20	60 (65)	75 (50)	40	75 (50)	40	51	40
Unknown	10	0 (65)	0 (50)	0	0 (50)	0	78	8
Average		36 (65)	43 (50)	12	43 (50)	12	60	10 (50)

1) Unknown feedstocks must be included in the table and the total feedstock mix per biofuel type must add up to 100%.

2) Percentages are calculated as a percentage of total data fields with known reporting for the following data fields: Biofuel Feedstock, Feedstock origin, Environmental Standard, Social Standard and Land Use in November 2005. For example if for soy oil the feedstock type and country of origin are always known, the Environmental and Social standard are known for 50% of the volume and no Land Use information is known, the overall percentage of known reporting for soy is (100%+100%+50%+50%+0%) / 5 = 60%.

3) Percentages meeting a Qualifying Standard include the fraction of feedstock which meets the RTFO Sustainable Biofuel Meta-Standard.

Table 4 – Example data for palm oil of Carbon and sustainability characteristics of specific feedstock. For each feedstock type, e.g. palm oil, a separate table must be included in the annual report. A separate table is not required if the feedstock represented less than 3% of the annual total.

General info		Sustainability info			Carbon		
%[1] of total palm oil[2]	Feedstock origin	Env. Standard	Social Standard	Land use in Nov 2005	Carbon intensity (g CO_2e / MJ)	Impact of LUC (g CO_2e / MJ)	GHG saving (%)
20	Malaysia	RSPO	RSPO	Cropland	51	0	41
60	Malaysia	-	-	Unknown	45	Unknown	48
20	Indonesia	-	-	Unknown	51	Unknown	41

1) Percentages are calculated on the basis of the energy in the fuel supplied.

2) Any batches of fuel with identical sustainability information that contributed less than 3% of the fuel produced from this feedstock may be aggregated or can be identified separately.

4.3. When to report?

The RTFO obligation period runs from 15th April one year to 14th April the following year and each annual C&S report should cover an obligation period.

The annual C&S report is due by 30th September after the end of the relevant obligation period – three months before the deadline for the RTFO Administrator to report to Parliament on the scheme's operation each year.

4.4. Expected reporting levels and targets

The Government proposes to set targets relating to three aspects of the carbon and sustainability reporting process. The proposed targets are shown in Table 5 . There will be no penalty for failing to meet the targets, but the targets are intended to illustrate the level of performance which the Government expects fuel suppliers to deliver. The Government will keep these targets under review to ensure that they remain challenging but realistic, and to take account of the development of new standards for individual feedstocks.

1) Sustainability performance targets.

The first set of targets relate to the percentage of fuel supplied in each obligation period that should meet a Qualifying Standard.

The targets will be overall targets for all feedstock reported by a fuel supplier. Therefore it will be possible for a fuel supplier to fail to achieve the target for a specific feedstock but still to achieve the overall target.

2) Greenhouse Gas (GHG) saving

The second set of targets relates to **the overall level of GHG saving achieved by the biofuel supplied in each obligation period**. The GHG savings of a biofuel are established by comparing the biofuel's carbon intensity against the displaced fossil fuel's carbon intensity. GHG savings must include any impact of land use change (identified in the monthly reports). Where information on land use change is not provided the GHG saving will be reported without this data and the RTFO Administrator will conduct an *ex post facto* analysis to assess the potential impact of land use change. Further details of the calculation are provided in Annex F and Annex G.

The level of GHG saving is an overall target for all fuels and feedstocks reported by a fuel supplier. Fuel suppliers will therefore be able to meet this target even if they do not meet it in respect of every batch of fuel that they supply.

3) Data reporting on sustainability characteristics

The Government intends to set targets for **the amount of data provided by transport fuel suppliers** (as opposed to "don't know" reports).

Whilst "don't know" reports are permitted, suppliers will be encouraged to identify and report accurate information about the feedstocks used. Targets for data reporting refer to the overall percentage of data fields within the monthly reports that are completed with known information i.e. 35% of the data fields within the monthly report for fuel supplied in the 2008/9 period is expected to be completed with known information. These data fields are Biofuel Feedstock, Feedstock origin, Environmental Standard, Social Standard and Land Use in November 2005.

Where a by-product has been used as the feedstock, reporting "by-product" will be counted as a completed report. Similarly, reporting "mechanised" will be counted as a completed field for the social standard column of highly mechanised feedstocks.

Table 5 – the targets that the Government intends to set.

Annual supplier target	2008-2009	2009-2010	2010-2011
Percentage of feedstock meeting a Qualifying Standard[1]	-	50%	80%
Annual GHG saving of fuel supplied	40%	50%	60%
Data reporting of sustainability characteristics[2]	35%	65%	80%

1) This target explicitly refers to Qualifying Standards. While other standards which have been benchmarked against the RTFO Sustainable Biofuel Meta-Standard may also be reported, these do *not* count towards this target.

2) Percentages are calculated as a percentage of total data fields completed with known information for the following data fields: Biofuel Feedstock, Feedstock origin, Environmental Standard, Social Standard and Land Use in November 2005.

4.5. How will the RTFO administrator use annual reporting data?

Suppliers' annual reports will be used by the RTFO Administrator in preparing his annual report to Parliament on the operation of the scheme. Some other characteristics of the annual report are outlined below.

- The annual report will not influence the issue of RTFCs.
- The annual reports may be published on the RTFO Administrator website with the exception of information disclosing the volume of fuel supplied.
- The RTFO Administrator may estimate the total greenhouse gas savings which have resulted from the RTFO in that year and conduct an ex post analysis to determine potential greenhouse gas emissions associated with land use reported as 'unknown'.
- The annual reports may be used to provide information for comparing supplier performance against the performance targets set out in table 5.

5. The Chain of Custody

Carbon and sustainability (C&S) data within the proposed RTFO C&S reporting model has to be verifiable. Therefore the C&S data reported by the fuel supplier has to be traceable back to the party or parties who generated the information. In order to ensure this, the Government proposes that transport fuel suppliers set up a chain of custody so that information is passed down supply chains. This chapter explains the chain of custody and gives an example of an effective chain of custody arrangement which is recommended to suppliers.

The detail of the proposal is set out below:

5.1. General

Terminology

1. Throughout this chapter the following terminology will be used:

- *Administrative batch:* any amount of product with identical sustainability characteristics. The sustainability characteristics are:
  - Fuel type
  - Feedstock
  - Feedstock origin
  - Environmental standard
  - Social standard
  - Land use
- *Input:* any physical input sourced by any party in the supply chain. For example rapeseed sourced by a rapeseed crusher or rapeseed oil sourced by a biodiesel producer.
- *Output:* any physical output supplied by any party in the supply chain. For example rapeseed supplied by a rapeseed farm or rapeseed oil supplied by a rapeseed crusher.

- *Conversion factor:* refers to the amount of output produced per unit of input. For example the oil extraction rate or the amount of biodiesel produced per unit of vegetable oil.
- *Inventory:* refers to a stock of physical product or C&S data.

Aggregating multiple administrative batches

Multiple administrative batches can be aggregated at any point in the supply chain provided the individual batches have identical sustainability characteristics as defined above. Administrative batches with different carbon intensities but identical sustainability characteristics can be aggregated – the resulting carbon intensity is calculated as a weighted average of the individual batches (based on volume for liquid products).

When to set up a chain of custody

In some situations a certified Chain of Custody will already exist and a new Chain of Custody does not necessarily need to be set up. This is the case when a fuel supplier reports a Qualifying Standard which has its own certified Chain of Custody (such as for Forest Stewardship Council). In that case the workings and the verification of the Chain of Custody are prescribed by the existing standard. The biofuel producer then needs only to be able to provide documentation to prove that they sourced specific volumes of feedstock certified according to the relevant existing standard. Note that there are several limitations in using a Chain of Custody system of an existing standard:

- At the time of writing, most of the benchmarked standards do not have a operational Chain of Custody, see Table 6.
- Existing sustainability standards currently do not contain carbon data and therefore no claims can be made concerning carbon performance in these cases: default values must be used.
- A Chain of Custody between the biofuel producer and the fuel supplier still needs to be set up if the Chain of Custody of the sustainability standard stops at the biofuel producer.

Table 6 – Chain of Custody for several existing standards and initiatives.

	Bulk commodity	Mass-balance	Book-and-claim
Forest Stewardship Council	Yes	Yes	-
Sustainable Agriculture Network/Rainforest Alliance	Yes	-	-
International Federation of Organic Agriculture Movements	Yes	-	-
Linking Environment And Farming	-	-	-
Roundtable on Sustainable Palm Oil		Under development	
Round Table on Responsible Soy		Under development	
Social Accountability 8000	-	-	-
Assured Combinable Crops Scheme	-	-	-
EurepGAP, Combinable Crops	-	-	-

These limitations require a Chain of Custody for the purpose of the RTFO. The following section of this chapter describes a detailed example of how a chain of custody could operate for the RTFO.

Some general principles of a chain of custody are set out below:

- Each party in the supply chain must keep written input and output records of the fuel's carbon and sustainability credentials including the quantity of the fuel sold and the C & S data.
- For any transaction, the traded amount of C&S data cannot exceed the traded amount of physical product.
- A company in the Chain of Custody can never sell more output with certain C&S data than it sourced input with similar C&S data

Scope

Each party in the biofuel supply chain, which at any point is the *legal owner* of the product, needs to put in place the administration needed for the Chain of Custody. If any company in the supply chain, that takes legal ownership over the product, does not keep the required records, the Chain of Custody ends at this company and no claims related to C&S data can be made by companies further down stream. The consequence of a break in the chain of custody is that the fuel supplier will have to use the default values for carbon intensity and may have to state that they "don't know" the provenance of their biofuel.

5.2. Working example of the Rules for a Chain of Custody

Responsibilities and procedures

Each company in the Chain of Custody should:

- Appoint the person or position with overall responsibility for compliance with the Chain of Custody procedures explained below
- Have written procedures and/or work instructions to ensure implementation of the requirements as explained below.

Selling products with C&S data

- A company that sells products with C&S data must specify the C&S data on the invoice or a document that the invoice refers to. The invoice or relevant document must at least include the following information:
  - The name and address of the buyer
  - The date on which the invoice was issued
  - Description of the product – this must correspond to the description of the product given in the input and output records
  - The quantity of the products sold with certain C&S data. If the invoice contains products with different C&S data, these shall be identified separately in such a way that it is clear to which products which C&S data refers.
- A company in the Chain of Custody can never sell more output with certain C&S data than its sourced input with similar C&S data (taking into account the relevant conversion factor). This means the periodic inventory of C&S data may never be negative
- For any transaction, the traded amount of C&S data can not exceed the traded amount of physical product.

Record keeping

Each company in the Chain of Custody needs to keep the following records.

- *Input and output records of C&S data.* Input records refer to the C&S data of products bought from a supplier. Output records refer to the C&S data of products sold to a buyer. For each administrative batch these records should include at least:
  - Invoice reference(s)
  - A description of the physical product to which the C&S data refer
  - The volume of physical input/output to which the C&S data refer
  - The supplying/receiving company
  - Transaction date
  - Any C&S data
- All this information will coincide with the information on the invoice(s) to which the input record refers.
- *Conversion factor records.* These records refer to the conversion factor of inputs to outputs (e.g. rapeseed to rapeseed oil). Each company in the supply chain can maintain records of its conversion factors. A company may have more than one conversion factor. If no records are kept for the conversion factor the default value for the respective conversion factor must be used (see *"Part 2 – Default values and fuel chains"*). For each conversion factor it must be clear from the records:
  - The input product it refers to
  - The output product it refers to
  - The units in which the conversion factor is expressed
  - The value of the actual conversion factor
  - When the specific conversion factor was valid[9].
- The conversion factors may also be integrated in the input, output or inventory records as long as the requirements listed here are met.
- *Periodic inventory of C&S data.* These records provide an insight in the balance of C&S data. Besides helping a company to manage its input-output balance these records also assist in the verification of a company's chain of custody records. The period can be no longer than one month and records should at least include:
  - The inventory of C&S data at the beginning of the respective period. It must be clearly specified whether this is expressed in input-equivalents (before conversion factor) or output-equivalents (after conversion factor)

9 Conversion factors will be valid for a period of one year.

- The volumes of inputs with identical C&S data in the respective period. These volumes must coincide with the input records described above
- The volume of outputs with identical C&S data in the respective period. These volumes must coincide with the output records described above
- The conversion factor(s) used in the respective period
- The inventory of C&S data at the end of the respective period. It must be clearly specified whether this is expressed in input-equivalents (before conversion factor) or output-equivalents (after conversion factor).

Records to keep of products from unknown origin

When the origin of the inputs is unknown, the only information required in the input record is the product description (e.g. rapeseed or rapeseed oil) and the volume.

Further guidance

Example formats for the above described records are given in Annex E. Other formats are acceptable provided they meet the requirements described.

5.3. Equivalence trading

Equivalence trading refers to the practice under the Common Agricultural Policy of the EU where crops grown under contract for energy use (either grown on set-aside or claiming the EU Energy Aid Payment) can be substituted by other material from within the EU which has not been grown under an energy contract. The RTFO will not affect this practice.

However, under the RTFO, the carbon and sustainability characteristics of the feedstock cannot be substituted in this exchange.

5.4. Verification

The Chain of Custody as described in this Chapter is not a full and established standard to which a company can become certified, such as that which the Forest Stewardship Council operates for example. The Chain of Custody is therefore subject to verification within the scope of the annual verification of the carbon and sustainability reports of fuel suppliers (see Chapter 5).

Over time consideration may be given to developing a full standard for a Chain of Custody against which companies can be certified or to developing alternative approaches which effectively balance risks against administrative burdens and costs.

6. Verification of company reporting

This chapter provides guidance on the proposed verification requirements for suppliers who submit annual reports and provides examples of good practice to assist with verification procedures.

The detail of the proposal is set out below:

6.1. General

In order to provide confidence in the carbon and sustainability claims, all information submitted in the annual RTFO C&S report must be verified[10] independently. The Administrator may impose a civil penalty on any supplier that does not supply the required independent verification.

Information in the annual report will include aggregated monthly C&S data as amended by any variance reports received and other qualitative information about the operations of the fuel supplier as set out in Chapter 4.

Following verification, the verifier will provide the fuel supplier with a formal limited-assurance opinion (a verification statement) about the quality of the annual reporting. There is no RTFO requirement for separate verification of monthly reports.

It is the responsibility of reporting organisations to provide an independent opinion on the annual report to the Administrator by 30th September. This opinion must be supplied, even if the accredited body is unable to provide a ‘clean’ opinion. Organising the verification is the responsibility of the fuel supplier.

While verification is required to ensure the accuracy and completeness of C&S data, there is no requirement for system certification of the reporting system.

6.2. Setting-up a System for Carbon and Sustainability Reporting

To be able to produce data that is of sufficient quality for reporting, fuel suppliers need to ensure that they and others in their supply chain have effective systems for C&S reporting.

Fuel suppliers should appoint a single point of contact with responsibility for C&S reporting.

10 Note that data is verified through sampling and not 100% of data will actually be checked.

Good practice

It is good practice to:

- Liaise with the supply chain to ensure awareness of the need for co-operation and for a chain of custody.
- Produce data in a manner that is as consistent as possible between years (allowing for improvements in method) and transparent.
- Remove unnecessary complexity from the reporting system
- Organise internal checks of the data
- Ensure all people supplying data are aware of the rigour required and that responsibility for supplying the data is allocated
- Map the data flow within the organisation, such as between spreadsheets
- Minimise the manual transfer of data
- Ensure adequate controls around the data, such as cell protection in spreadsheets
- Document the system (who, what, when etc.)
- Track data over time to help identify any misstatement.

6.3. Which data will be verified?

There is no requirement to pass physical evidence (such as copies of invoices etc) from farms, processors or other suppliers along the supply chain. The company which generates the carbon and/or sustainability data retains this evidence. In verifying the carbon and sustainability data reported by a fuel supplier the verifier is able to work back up the supply chain to the source data using the chain of custody records, as described in Chapter 5. The co-operation of those in the supply chain is therefore vital.

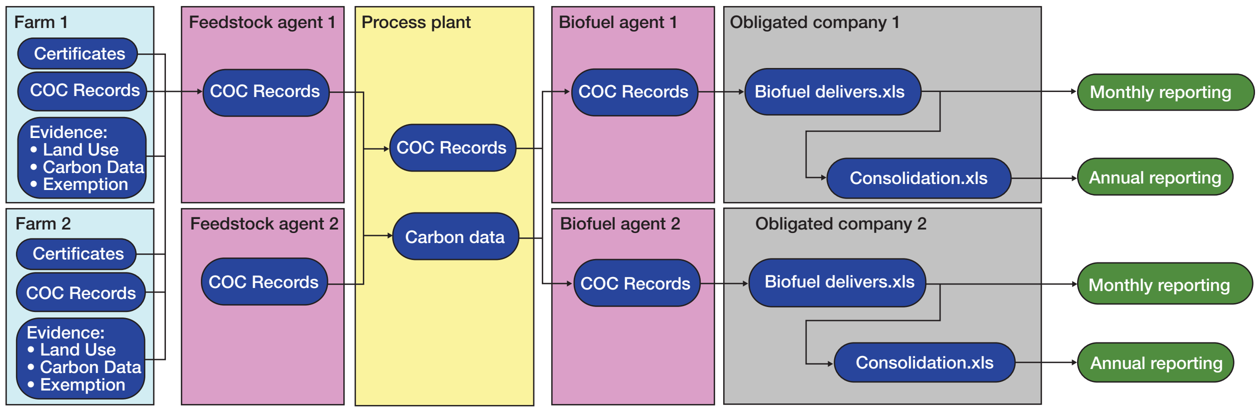
With respect to sustainability data, certificates of accepted standards are sufficient proof of compliance with the criteria and indicators of that standard: these will not be verified again. If it is claimed that the RTFO Sustainable Biofuels Meta-Standard is met, certificates from the supplementary checks will be required as evidence. (See Annex A for a list of accepted standards and Annex C for supplementary checks needed for the RTFO Sustainable Biofuel Meta-Standard).

All other C&S data is subject to verification, for example:

- Carbon data
- Evidence of Land Use in November 2005
- Chain of Custody records
- Other information provided in the annual report.

An example of the data flow with a simplified supply chain is shown below.

Figure 1 – Example of the records kept by each party in the supply chain.



Note that each party keeps Chain of Custody records but that evidence does not need to be passed to parties downstream in the Chain of Custody. Through the Chain of Custody records, the verifier will be able to trace back to the party which generated the carbon and/or sustainability data such that the verifier can check the evidence for this.

Good systems reduce the cost of verification

The greater the confidence that can be placed on controls, the less effort that needs to be given to verifying the data, for the same level of assurance. The cost of verification can, therefore, be reduced if the verifier has confidence in the system that produced the data. Evidence of the effectiveness of controls can come from internal sources, such as management reviews and internal audits, as well as external audits, for example, of the chain of custody.

6.4. How to organize the verification

The fuel supplier is responsible for engaging a verifier approved to carry out a ***limited-assurance*** audit of the annual C&S report. The term 'limited-assurance' is defined in the International Standard on Assurance Engagements (ISAE 3000).

In selecting a verifier suppliers may wish to consider the following guidance. For example, the verification body could be required to demonstrate that it:

- is independent of organisations involved in the production of biofuels
- has established and maintains personnel records, which demonstrate that the verification personnel are competent
- has effective procedures for the training and recruitment of competent staff (employees and contractors)
- ensures that the personnel involved in verification are competent for the functions they perform

- has systems to monitor the performance of auditors and reviewers, which are reviewed regularly
- keeps up with verification best practice.

Limited assurance audits aim to provide moderate assurance that the annual C&S report is without material misstatement. As such verifiers need to state that nothing has come to their attention to indicate material misstatement, given an appropriate level of investigation. ISAE 3000 provides guidance to verifiers about how they must go about the audit. It should normally be possible for verifiers to obtain moderate assurance from a site visit to the fuel supplier and telephone interviews along the supply chain.

Verification of the annual report will require the fuel supplier to go through the following steps:

1. Engage a verification body approved to carry out a limited-assurance audit of the annual C&S report as set out in ISAE 3000.
2. Submit the draft annual C&S report to the verifier
3. Submit supporting information and evidence held by the fuel supplier
4. Host any visits from the verifier
5. Respond to any verifier questions
6. Correct any material misstatement identified by the verifier
7. Submit the verification opinion with the annual report.

The verifier will wish to visit the fuel supplier. The verifier will review the consolidation process and meet the person responsible for the submission.

The verifier will work along the supply chain, tracing the data flow and testing controls. The verifier may select a risk-based approach, so not every organisation in the supply chain may be contacted. The exact approach may vary with each verifier and supply chain.

The duration of the verification process may take a number of weeks, particularly if the supply chain is complex or long and responses to information requests from the verifier are delayed. It is recommended that suppliers engage the verifier long before the deadline date for verifications. The verifier may wish to carry out tests during the year to reduce any end of year bottlenecks.

Good practice

It is common verification practice for data to be supplied to the verifier in an organised evidence pack. This would be expected to include:

- The draft annual C&S report
- High-level description of supply chain (as is known, to help the verifier)

- Chain of Custody records
- Contact details, of at least the organisations in the previous stages in the supply chain
- Calculation spreadsheets (preferably supplied electronically so that verifiers can test the formulas)
- Physical evidence to support qualitative statements which refer to the fuel supplier itself.

All the above information would be needed to verify the data. If not provided in an ordered fashion, the verifier will need to request information, which increases the verification effort required.

6.5. Verifier opinions

The verifier will submit an opinion for the annual C&S report.

Misstatement by 5% is normally taken to be a material error. If misstatement is material, and the data can not be corrected, the verifier will not be able to give a 'clean' opinion on the data.

The opinion for the annual C&S report could be worded, for example, as below:

"Nothing has come to our attention that causes us to believe that internal control is not effective, in all material respects."

If there is material misstatement, the opinion could be worded, for example, as below:

> "Nothing has come to our attention that causes us to believe that internal control is not effective, in all material respects, with the exception of:
>
> - X
>
> - Y
>
> - Z."

It is standard practice for the verifier to submit a report, in addition to the opinion, to the client. The opinion forms part of the annual reporting requirements set out in chapter 4.

Annex A: Guidance on sustainability standards

Currently benchmarked standards

A *selection* of existing standards have already been benchmarked against the RTFO Sustainable Biofuel Meta-Standard to evaluate whether they are a Qualifying Standard for the RTFO. The results are shown in Table 7. The detailed results of the benchmark are included in Annex C[11]. More standards can and will be benchmarked by the Administrator once it is established.

Table 7 – List of benchmarked standards. For each standard it is shown whether it is a Qualifying Standard for the environmental and/or social criteria of the RTFO.

	Qualifying Environmental Standard?	Qualifying Social Standard?
Linking Environment And Farming Marque	Yes	No
Roundtable on Sustainable Palm Oil	Yes	Yes
Sustainable Agriculture Network/Rainforest Alliance	Yes	Yes
Basel criteria for soy	Yes	Yes
Forest Stewardship Council	Yes	No
Social Accountability 8000	No	Yes
Assured Combinable Crops Scheme[12]	No	No
EurepGAP	No	No
International Federation of Organic Agriculture Movements	No	No

11 Originally developed to deliver assurance for food safety, ACCS currently does not meet the environmental 'qualifying standard' requirements but is considering the addition of relevant criteria that will classify it as a qualifying standard. Evidence collected to support cross compliance obligations may be used as evidence for relevant additional criteria within standards. The periodicity and scope of audits for cross compliance (1% of farms per year) is not considered sufficient for cross compliance to be considered as a stand-alone scheme within this reporting scheme.

12 ACCS has been used in the benchmarking comparison as the major combinable crops assurance scheme under AFS. Other schemes have not been excluded and may be benchmarked at a later date.

Short term solutions for standards in development

Several of the benchmarked standards are not yet operational and for sugar cane no initiative with a clear set of draft criteria is available. To offer a short term solution for these cases the following alternatives will be accepted for the RTFO:

- Palm oil: the Roundtable on Sustainable Palm Oil (RSPO) is not fully operational therefore the following production units are accepted as meeting the RSPO criteria and thereby the qualifying level of sustainability for the RTFO:
  - Successful audit against the RSPO criteria and indicators, and
  - Feedstock producer is a member of the RSPO
- Soy oil: the Round Table on Responsible Soy (RTRS) is not fully operational therefore the following production units are accepted as meeting the Basel criteria and thereby the qualifying level of sustainability for the RTFO:
  - Successful audit against the Basel criteria and indicators, except criterion 2.3 on genetically modified material, and
  - Feedstock producer is a member of the RTRS
- Sugar cane: for as long as an accepted standard for sugar cane is not in operation the following production units are accepted as meeting the RTFO Sustainable Biofuel Meta-Standard:
  - Successful audit against the RTFO Sustainable Biofuel criteria and indicators, and
  - Membership of Better Sugarcane Initiative (BSI) or equivalent

The audits must meet the following requirements:

- The verification body is accredited to ISO 65
- The audits must be carried according to ISO 19011.

Benchmarking additional standards

Procedure

A company can request the Administrator to perform a benchmark of an existing sustainability standard. The exact procedure for this will be determined by the Administrator but the Government suggests that the following may be a workable procedure:

- The company files a request for benchmark for a particular standard with the Administrator which includes at least the following:
  - The formal description of the Standard.
  - The most recent version of the Standard's Criteria and Indicators.

  - The most recent version of the Standard’s procedures and requirements for the auditing/certification process, the auditor and the certifying body.
- The Administrator will benchmark the Standard against the RTFO Meta-Standard and conclude whether it is a Qualifying Standard, considering the guidance given below.
- The results are made publicly available.

Guidelines for the Administrator for the norm for Qualifying Standards

The following norms were used for the benchmarks performed by Ecofys and DNV, which are also recommended to the RTFO Administrator for future benchmarks.

Norm for environmental criteria and indicators

To become a Qualifying Environmental Standard the following criteria requirements must be met:

- Full compliance with all criteria referring to compliance with national legislation (2.1, 3.1, 4.1, 5.1)
- On all principles one ‘partial compliance’ criterion is permitted per principle, with a maximum of three in total.
- Thereby, full compliance with a criterion is only awarded if the RTFO criterion is met by a mandatory criterion in the benchmarked standard.

Norm for social qualifying standards

To become a Qualifying Social Standard the following criteria requirements must be met:

- Of the 11 minimum requirement criteria of principle 6, 7 must be fully complied with.
- On principle 7 on land right issues and community relations, one partial compliance is permitted.

Thereby, full compliance is only awarded if the RTFO criterion is met by a mandatory criterion in the benchmarked standard

Norm for benchmark of audit quality

No fixed norm is currently given for the audit requirements because different standards have different approaches to control the quality of the audit and certification process for their standards. This makes it difficult to define a common set of minimum criteria for the audit and certification process. Based on an analysis of audit requirements of existing standards, see Table 10 in Annex C, all currently benchmarked standards are judged to provide sufficient credibility for the purpose of the RTFO, with the exception of LEAF Marque certificates that have been issued by a body that is not accredited[13].

13 Approximately 10% of all LEAF Marque certificates are issued by non-accredited certification bodies.

Guidelines for future auditing quality requirements

The Administrator is advised to develop a set of minimum auditing quality requirements for future benchmarks. Guidelines for such future requirements are given in the table below.

Table 8 – Guidelines for the Administrator for future requirements for the auditing quality of Qualifying Sustainability Standards.

Who is responsible for accreditation?	What accreditation process is required?	Do all farms need to be audited annually?	How are audit programmes and audits activities to be managed?	What is the required competence of verifiers?
Certification bodies must be accredited by the body that is responsible for the standard in question. Where standard bodies look to national accreditation bodies (such as UKAS) to organise accreditation, accreditation must be achieved through the appropriate national accreditation body. These bodies must be Accreditation Body Members of the International Accreditation Forum (IFA)[1].	Standards will only be accepted that have a rigorous accreditation process (compliant with ISO Guide 65, which is due to be replaced by ISO 17021 in 2008), or justified equivalent. ISO Guide 65 sets out the general requirements for bodies operating assessment and certification/ registration of quality systems.	Yes (surveillance checks are acceptable if the farms have received a full audit within three years). Risk-based auditing is acceptable where management systems are common and co-ordinated.	As stated in ISO19011, or justified equivalent. The ‘Plan, Do Check and Act’ of the audit programme must be managed appropriately.	As stated in ISO19011, or justified equivalent. Lead auditors must have carried out at least three complete audits for a total of at least 15 days of auditing experience acting in the roles of an audit team leader, under the direction and guidance of an auditor competent as an audit team leader. These three audits should be completed within the last two consecutive years.

1) A full list of IAF Accreditation Body Members are listed on the IAF website (www.iaf.nu).

Claiming sustainability standards

Claiming a Qualifying Standard

The farm from which the biofuel feedstock originates needs to be able to show the certificate from which it appears that it is certified by a Qualifying Standard. (This can be checked by the verifier in the annual verification, see Chapter 5.)

For sustainability standards under development such as the RSPO, the farm needs to be able to show documented proof of a successful audit against RSPO draft criteria.

Claiming the RTFO Sustainable Biofuel Meta-Standard

In order to claim the RTFO Sustainable Biofuel Meta-Standard, the farm from which the biofuel feedstock originates needs to be able to show the certificate demonstrating an existing standard has been met and documented proof of a successful audit on the gap criteria as they relate to the existing standard. These are called '*supplementary checks'* and are performed on existing standards that are determined as Qualifying Standards by the RTFO.

Supplementary checks may only be performed by auditors accredited for the existing standard to which the gap criteria apply.

Circumstances in which sustainability reporting requirements differ.

There are two situations in which providing details on part(s) of the sustainability reporting requirement is not applicable:

- When the feedstock used for biofuel production is a 'by-product'
- When the feedstock used for biofuels is produced with limited labour inputs (mechanised production).

By-products

For by-products (also including waste products) data on the sustainability characteristics (environmental and social standard and land use) of the by-product are not required and suppliers fill 'by-product' into the relevant data fields.

Procedures for defining by-products

The RTFO Administrator will define the feedstocks that are considered by-products. The following definition is proposed:

Definition

By-products are products that have an economic value of less than 10 of the value of the crop as a whole as it leaves the farm or of the total value of product leaving the factory. Thereby the by-product should be a fundamentally different product than the main product[14].

By-products also include used products which have a value of less than 10% of the value of the same unused product.

14 Refining fractions, for example, are not considered by-products

For the purpose of this draft Guidance and Requirements, the following products are considered by-products:

- Tallow
- Used cooking oil
- Municipal Solid Waste
- Animal manure

The exact procedure for requesting that an additional feedstock be considered as a by-product will be determined by the Administrator but the following guidelines are given:

- A company requests the RTFO Administrator to define a specific feedstock as a by-product.
- The RTFO Administrator agrees to conduct an assessment and makes publicly known on its website that the product is being assessed.
- The Administrator determines whether the product meets the criteria of a by-product. In using market price information the Administrator will use the average market price of the preceding calendar year.
- The Administrator publishes the results and its decision on its website.
- The decision of the RTFO Administrator will be valid at least for the remainder of the obligation period in which the request is made (from 15 April of one year to 14 April the following year).
- If the RTFO Administrator chooses not to review the categorisation of a product as a by-product, the decision will remain valid for the next obligation period.
- If the RTFO Administrator chooses to review the categorisation of a product as a by-product, it will do so before the end of March and publish the renewed results on its website before the end of March. The renewed results will be valid for the next obligation period, starting on the 15th of April.

Labour conditions in mechanised feedstock production

Production units using limited labour per hectare (mechanised production) are not required to report on labour conditions. Note that this does not include the social criteria on land right issues (principle 7 in Table 9)

Definition of mechanised farming

Mechanised production units are production units for which the labour requirements do not exceed 5 man-days/ha/y.

Based on this definition, reporting on labour conditions is not required for the following crops:

- Rapeseed
- Maize
- Wheat
- Sugar beet
- Soy beans

Claiming mechanised farming

Production units growing one of the above mentioned highly mechanised energy crops are defined as highly mechanised by default. Production units growing other crops but which also have labour requirements of less than 5 man-days/ha/y need to be able to show documented evidence that their labour requirements indeed do not exceed this threshold. This data is subject to verification during the annual verification of the carbon and sustainability reports of the fuel supplier.

Reporting on land right issues when reporting on labour conditions is not required

Farms which are not required to report on labour conditions still need to meet the social criteria on land right issues. In this case the criteria on land right issues either need to be covered by the environmental Qualifying Standard or must be met through supplementary checks. Currently all qualifying environmental standards also meet the criteria on land right issues (principle 7 in Table 9), see benchmark results in Annex C.

If the criteria on land right issues are not covered through an environmental Qualifying Standard or through supplementary checks, the social standard is not met and will not count towards the indicative target.

Annex B: Criteria and Indicators of the RTFO Sustainable Biofuel Meta-Standard

Environmental criteria and indicators

1. The tables below show the environmental sustainability criteria and indicators for the RTFO Sustainable Biofuel Meta-Standard. All 'minimum requirement' criteria and indicators must be met for the RTFO Sustainable Biofuel Meta-Standard. The 'recommended' criteria and indicators are not required for the RTFO Sustainable Biofuel Meta-Standard but are considered good practice. They indicate where the RTFO Sustainable Biofuel Meta-Standard should develop in the long term. Below, all criteria and indicators are 'minimum requirements' unless stated otherwise.

Principle 1: CARBON CONSERVATION	**Biomass production will not destroy or damage large above or below ground carbon stocks**
Criterion	**Indicators**
1.1 Preservation of above and below ground carbon stocks (reference date 30-11-2005).	• Evidence that biomass production has not caused direct land use change with a carbon payback time exceeding 10 years[1]. • Evidence that the biomass production unit has not been established on soils with a large risk of significant soil stored carbon losses such as peat lands, mangroves, wetlands and certain grasslands

1) Guidance on the 'carbon pay back time' is given in Annex G.

Principle 2: BIODIVERSITY CONSERVATION	**Biomass production will not lead to the destruction or damage of high biodiversity areas**
Criterion	**Indicators**
2.1 Compliance with national laws and regulations relevant to biomass production and the area where biomass production takes place.	• Evidence of compliance with national and local laws and regulations with respect to: – Land ownership and land use rights – Forest and plantation management – Protected and gazetted areas – Nature and wild life conservation – Land use planning – National rules resulting from the adoption of CBD[15] and CITES[16]. • The company should prove that: – It is familiar with relevant national and local legislation – It complies with these legislations – It remains informed on changes in legislation

15 http://www.biodiv.org/com/convention/convention.shtml

16 http://www.cites.org/eng/disc/text.shtml

2.2 No conversion of high biodiversity areas after November 30, 2005	• Evidence that production does not take place in gazetted areas. • Evidence that production does not take place in areas with one or more HCV areas[17]: – HCV 1, 2, 3 relating to important ecosystems and species – HCV 4, relating to important ecosystem services, especially in vulnerable areas – HCV 5, 6, relating to community livelihoods and cultural values. • Evidence that production does not take place in any areas of high biodiversity as listed below this table.
2.3 The status of rare, threatened or endangered species and high conservation value habitats, if any, that exist in the production site or that could be affected by it, shall be identified and their conservation taken into account in management plans and operations.	• Documentation of the status of rare, threatened or endangered species and high conservation value habitats in and around the production site. • Documented and implemented management plan on how to avoid damage to or disturbance of the above mentioned species and habitats.
Recommendation	
2.4 Preservation and/or improvement of biodiversity on production sites	• Evidence that a minimum of 10% of the production area is set aside and properly managed for nature conservation and ecological corridors. • Evidence of good agricultural practices with respect to the conservation and improvement of biodiversity on and around the production site.

17 The definition of the 6 High Conservation Values can be found at http://www.hcvnetwork.org.
Currently no comprehensive maps exist which define HCV areas. For many areas it will therefore still be necessary to assess whether HCV's are present or not.
The following initiatives are helpful in defining areas with one or more HCV's:

- Conservation International – Biodiversity Hotspots
- Birdlife international – Important Bird Areas
- The WWF G200 Ecoregions : the regions classified 'vulnerable' or 'critical/endangered'.
- European High Nature Value Farmland

Principle 3: SOIL CONSERVATION	**Biomass production does not lead to soil degradation**
Criterion	**Indicators**
3.1 Compliance with national laws and regulations relevant to soil degradation and soil management.	• Evidence of compliance with national and local laws and regulations with respect to: – Environmental Impact Assessment – Waste storage and handling – Pesticides and agro-chemicals – Fertilizer – Soil erosion • Compliance with the Stockholm convention (list of forbidden pesticides). • The company should prove that: – It is familiar with relevant national and local legislation – It complies with these legislations – It remains informed on changes in legislation

3.2 Application of *good agricultural practices* with respect to: – Prevention and control of erosion – Maintaining and improving soil nutrient balance – Maintaining and improving soil organic matter – Maintaining and improving soil pH – Maintaining and improving soil structure – Maintaining and improving soil biodiversity – Prevention of salinisation	• Documentation of soil management plan aimed at sustainable soil management, erosion prevention and erosion control. • Annual documentation of applied good agricultural practices with respect to: – Prevention and control of erosion – Maintaining and improving soil nutrient balance – Maintaining and improving soil organic matter – Maintaining and improving soil pH – Maintaining and improving soil structure – Maintaining and improving soil biodiversity – Prevention of salinisation *Recommendations* • Records of annual measurements of: – Soil loss in tonnes soil/ha/y – N,P,K balance – SOM and pH in top soil – Soil salts content
Recommendation	
3.3 The use of agricultural by-products does not jeopardize the function of local uses of the by-products, soil organic matter or soil nutrients balance.	• Documentation that the use of by-products does not occur at the expense of important traditional uses (such as fodder, natural fertilizer, material, local fuel etc.) unless documentation is available that similar or better alternatives are available and are applied. • Documentation that the use of by-products does not occur at the expense of the soil nutrient balance or soil organic matter balance.

Principle 4: SUSTAINABLE WATER USE	**Biomass production does not lead to the contamination or depletion of water sources**
Criterion	**Indicators**
4.1 Compliance with national laws and regulations relevant to contamination and depletion of water sources.	• Evidence of compliance with national and local laws and regulations with respect to: – Environmental Impact Assessment – Waste storage and handling – Pesticides and agro-chemicals – Fertilizer – Irrigation and water usage • The company should prove that: – It is familiar with relevant national and local legislation – It complies with these legislations – It remains informed on changes in legislation
4.2 Application of good agricultural practices to reduce water usage and to maintain and improve water quality.	• Documentation of water management plan aimed at sustainable water use and prevention of water pollution. • Annual documentation of applied good agricultural practices with respect to: – Efficient water usage. – Responsible use of agro-chemicals – Waste discharge *Recommendations* • Records of annual measurements of: – Water sources used (litres/ha/y) – BOD level of water on and nearby biomass production and processing.

Principle 5: AIR QUALITY	**Biomass production does not lead to air pollution**
Criterion	**Indicators**
5.1 Compliance with national laws and regulations relevant to air emissions and burning practices	• Evidence of compliance with national and local laws and regulations with respect to: – Environmental Impact Assessment – Air emissions – Waste management – Burning practices • The company should proof that: – It is familiar with relevant national and local legislation – It complies with these legislations – It remains informed on changes in legislation
5.2 No burning as part off land clearing or waste disposal.	• Evidence that no burning occurs as part of land clearing or waste disposal, except in specific situations such as described in the ASEAN guidelines on zero burning or other respected good agricultural practices.

List of protected areas referred to in criterion 2.2

- UNESCO World heritage sites[18];
- IUCN List of Protected Areas categories I, II, III and IV[19], according to the list available from 2003[20] or more up to date lists or national data;
    - RAMSAR sites (wetlands under the Convention on Wetlands)[21], according to the available list[22] of more up to date lists or national data;

Social criteria and indicators

The table below shows the social criteria and indicators for the RTFO Sustainable Biofuel Meta-Standard.

Table 9 – Social criteria and indicators for the RTFO Sustainable Biofuel Meta-Standard. All 'minimum requirement' (MR) criteria and indicators must be met for the RTFO Sustainable Biofuel Meta-Standard. The 'recommended' (R) criteria and indicators are not required for the RTFO Sustainable Biofuel Meta-Standard but are considered good practice. They indicate the direction the RTFO Sustainable Biofuel Meta-Standard should develop in the long term.

Criteria	Indicators	
6. Biomass production does adversely effect workers rights and working relationships		
C 6.1 Compliance with national law on working conditions and workers rights	Certification applicant should comply with all national law concerning working conditions and workers rights.	MR
C 6.2 Contracts	Certification applicant should apply all category of employees (incl temporary workers) with a legal contract in which criteria below are registered.	MR

18 http://whc.unesco.org/en/list

19 IUCN defines a protected area as: an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means, and subdivides protected areas into six categories: 1a: Strict nature reserve/wilderness protection area; 1b: Wilderness area; II: National park; III: Natural monument; IV: Habitat/Species management area; V: Protected landscape/seascape; VI: Managed resource protected area. Source: www.wwf.de/fileadmin/fm-wwf/pdf-alt/waelder/WWF-position_Protected_Areas_03.pdf.

20 http://www.unep-wcmc.org/wdpa/unlist/2003_UN_LIST.pdf

21 http://www.ramsar.org/

22 ttp://www.ramsar.org/index_list.htm

Criteria	Indicators	
C 6.3 Provision of information	Certification applicant must show evidence that all workers are informed about their rights (incl. bargain rights).	MR
C 6.4 Subcontracting	When labour is contracted or subcontracted to provide services for the certification applicant, the certification applicant must demonstrate that the subcontractor provide it's services under the same environmental, social and labour conditions as required for this standard.	MR
C 6.5 Freedom of association and right to collective bargaining	Certification applicant must guarantee the rights of workers to organize and negotiate their working conditions (as established in ILO conventions 87 en 98). Workers exercising this right should not be discriminated or suffer repercussions.	MR
C 6.6 Child labour	Certification applicant must guarantee that no children below age of 15 are employed. Children are allowed to work on family farms if not interfering with children's educational, moral, social and physical development (workday inclusive school and transport max. 10 hours).	MR
C 6.7 Young workers	The work carried out shall not be hazardous or dangerous to the health and safety of youth workers (age 15 -17). It shall also not jeopardise their educational, moral, social and physical development.	MR
C 6.8 Health and safety	All certification applicants should be required to meet basic requirements including potable drinking water, clean latrines or toilettes, a clean place to eat, adequate protective equipment and access to adequate and accessible (physically and financially) medical care.	MR
	All certification applicants shall ensure that workers have received regular health and safety training appropriate to the work that they perform.	MR
	All certification applicants shall identify and inform workers of hazards, and adopt preventive measures to minimise hazards in the workplace and maintain records of accidents.	MR

Criteria	Indicators	
C 6.9 Wages/ compensation	Wageworkers must be paid wages at least equivalent to the legal national minimum wage or the relevant industry standard, which ever is higher.	MR
	Workers must be paid in cash, or in a form that is convenient to them and regularly.	MR
	The certification applicant must pay the workers for unproductive time due to conditions beyond their control.	R
	Housing and other benefits shall not be automatically deducted from the minimum wage/or relevant industry wage as an in kind payment.	R
	Where the certification applicant uses pay by production (piecework) system, the established pay rate must permit the worker to earn the minimum wage or relevant industry average (which ever is higher) during normal working hours and under normal operating conditions).	R
C 6.10 Discrimination	In accordance with ILO Conventions 100 and 111, there is no discrimination (distinction, exclusion, or preference) practised that denies or impairs equality of opportunity, conditions, or treatment based on individual characteristics and group membership or association like: Race, Caste, National Origin, Religion, Disability, Gender, Sexual Orientation, Union Membership, Political Affiliation, Age, marital status and those with HIV/AIDS, seasonal, migrant and temporary workers.	MR
C 6.11 Forced Labour	Standards shall require that the certification applicant not engage in or support forced labour including bonded labour as defined by ILO conventions 29 and 105. The company must not retain any part of workers' salary, benefits, property, or documents in order to force workers to remain on the farm. The company must also refrain from any form of physical or psychological measure requiring workers to remain employed on the farm. Spouses and children of contracted workers are not required to work on the farm.	MR

Criteria	**Indicators**	
C 6.12 Working hours	Usual working hours shall not exceed eight hours a day and 48 hours a week.	R
	Workers must have a min. of 24 hours rest for every seven day period.	R
	Overtime during seasonal peaks allowed, needs to be voluntary, should be paid at premium rate. Adequate brakes (every 6 h, 30 minutes). For heavy or dangerous work shorter periods and longer breaks should be allowed.	R
7. Biomass production does not adversely affect existing land rights and community relations		
C 7.1 Land right issues	The right to use the land can be demonstrated and does not diminish the legal or customary rights of other users and respects important areas for local people.	MR
C 7.2 Consultation and communication with local stakeholders	No new plantings are established on local peoples' land without their free, prior and informed consent. The farm can demonstrate that it has and implements policies and procedures for consulting and communicating with populations and local interest groups regarding plans for expansion, construction, sale or change of owner, administrative or operative restructuring or other changes that could affect these groups.	MR

Annex C: Benchmark of Standards

This annex includes the detailed results of the benchmarks performed of existing or developing sustainability standards. Benchmarks have been performed on two aspects:

- The criteria and indicators if the sustainability standard
- The auditing quality of the sustainability standard

Criteria and indicators

The tables below shows the detailed results of the benchmark performed on the RTFO criteria and indicators against the criteria and indicators of existing standards.

Three scores have been assigned in the benchmark:

- Y: indicating that the criterion and its indicators are sufficiently met by the benchmarked standard.
- X: indicating that the criterion and its indicators are not or insufficiently met by the benchmarked standard
- P: indicating that the criterion and its indicators are partly met by the benchmarked standard. There can be three reasons for this:
  - Of the various indicators for one criterion several are met and several are not met.
  - The subject covered by a criterion is addressed but less stringent. For example, several standards state that destruction of primary forest is forbidden but do not give a reference year. As the reference year is considered important this leads to a score "P".
  - The Meta-Standard indicators are fully met but are not mandatory for certification.

All Ps and Xs form gap-criteria. In order to be able to claim the RTFO Sustainable Biofuel Meta-Standard, successful supplementary checks on all gap-criteria of the Qualifying Standard are required.

Supplementary checks are only relevant to enable Qualifying Standards to reach the RTFO Sustainable Biofuel Meta-Standard. Supplementary checks should not be used to reach a Qualifying Standard.

Principles and Criteria	SAN/RA	RSPO	Basel	LEAF	ACCS	EurepGAP IFA	FSC	SA8000	IFOAM
P 1. Carbon Conservation									
C 1.1 Preservation of above and below ground carbon stocks (reference date 01-11-2005).	P P2 carbon capture C 2.1 (ecosystem conserv') C 9.5 cutting of natural forest cover for new production areas is forbidden	P 7.3 no conversion primary forest and HCVA nov 2005 7.4 No plantation on peat soil > 3m	P 3.1.1, no conversion of primary and HCVA july 2004 3.1.2. no forest conversion without compensation 1994	P P6	P 1.0 Awareness of Defra COPs for soil, air and water Conservation of peat lands	X	P 10.1 natural forest conservation and restoration.	X	P 2.1.2. clearing of primary ecosystem is prohibited
P2. Biodiversity conservation									
C 2.1 Compliance with national laws and regulations relevant to biomass production and the area where biomass production takes place.	✓ 1.1 manage social and environmental aspects in compliance with applicable law 1.6 / 2.4	✓ 2.1 in general	✓ 1.1 general	✓ 1.4 farm policy need to comply with all regulatory and legislative requirements	✓ 1.0, 1.1 compliance with legislation is part of COP compliance	✓ Introduction: any applicable legislation stricter than EurepGAP must be complied with	✓ P 1 general	X	X
C 2.2 No conversion of high biodiversity areas after 01-11-2005	P P9 P2 (ecosystem conservation) 2.2 no specific date	✓ 7.3 no conversion primary forest and HCVA **Nov 2005**	✓ 3.1.1 No conversion after **31 July '04** 3.1.2 compensation from 1 **Jan '95 - 31 July '04**	P P6 Extensive set of criteria	X	X	✓ 6.10 no conversion in HCV forest. 10.9 no conversion from natural forest after **November 1994**	X	P 2.1.2. clearing of primary ecosystem is prohibited
C 2.3 Indentification and conservation of important biodiversity on and around the production unit.	✓ 2.3 within 1 km, communication with owner of natural park	✓ 5.2 (+on-farm practice)	✓ 3.3.1 and 3.3.2	✓ P6 Integrate farming and biodiversity management	X	P 1.6 only recommendations and minor musts.	✓ P6 conserve biodiversity	X	✓ 2.1 Organic farming benefits the quality of ecosystems 2.1.2. clearing of primary ecosystem is prohibited
Recommendations									
2.4 Preservation and/or improvement of biodiversity on production sites	✓ P 2	P 5.2	✓ 3.3.2	P 6.2.2 5%	X	P 1.6.2.2 Action plan to enhance habitats and biodiversity on the farm (Minor must)	✓ P6 .4	X	P 2.1 / 2.1.2. as above

Principles and Criteria	SAN/RA	RSPO	Basel	LEAF	ACCS	EurepGAP IFA	FSC	SA8000	IFOAM
P3. Soil conservation									
C 3.1 Compliance with national laws and regulations relevant to soil degradation and soil management.	✓ 1.1 general compliance national law	✓ 2.1	✓ 1.1 general	✓ 1.2.1	✓ COP for soil and water	✓ Introduction: any applicable legislation stricter than EurepGAP must be complied with	✓ P 1 general	X	X
C 3.2 Application of best practices to maintain and improve soil quality. o Erosion control o Soil nutrient balance o Soil organic matter o Prevention of salinisation o Soil structure	✓ P9 missing salinisation	✓ 4.2 / 4.3 missing salinisation	✓ 2.1.1 / 2.1.2 / 2.1.3, 2.4.2 missing salinisation	✓ 2.2.1 –2.2.10 Soil erosion section, 2.4.1 – 2.4.14 Crop nutrition	✓ COP for soil and water	✓ 2.3.soil and substrate management / 2.4 fertilizer	✓ 6.5 control erosion, 10.6 improve or maintain soil structure, fertility an d biol. Activity	X	✓ 2.1 2.2.1 t-m 2.2.5 4.3.1 en 4.4
Recommendations									
3.2 a Measurements	✓ P9	X	X	✓ 2.4 / 2.10	✓ COP for soil and water	P 2.4 Records on fertilizer use 2.6 records on chemicals	X	X	X
C 3.3 The use of agricultural by-products does not jeopardize the function of local uses of the by-products, soil organic matter or soil nutrients balance.	✓ 10.1 used as fertilizer	P 5.3 recycled and reused	X	✓ 2.4	X	X	X	X	✓ 2.2.3 used as fertilizer
P 4. Sustainable Water Use									
C 4.1 Compliance with national laws and regulations relevant to contamination and depletion of water sources.	✓ 4.2 / 4.4 / 4.5	✓ 2.1	✓ 1.1 general	✓ 1.2.1	✓ Covered by compliance with soil and water COPs [C.1.1 above]	✓ Introduction: any applicable legislation stricter than EurepGAP must be complied with	✓ P 1 general	X	X
C 4.2 Application of *best practices* to reduce water usage and to maintain and improve water quality.	✓ P4	✓ 4.4	✓ 2.1.4 / 2.1.5 / P 2.2 chemical use	✓ 2.7.1 –2.7.8 Irrigation and water storage / 3.7.4	✓ Covered by compliance with soil and water COPs [C.1.1 above]	✓ 1.5.2.1 waste man. plan to avoid contamination of water 1.6.1.4 advice from water authorities	P 10.6 impacts on water quality , quantity	X	✓ 2.1 2.2.4 t-m 2.2.6
Recommendations									
4.2 b Records	✓ P4	X	X	✓ 2	X	P 2.5.1.3 records of irrigation water usage	X	X	X
P5. Air quality									
C 5.1 Compliance with national laws and regulations relevant to air emissions and burning practices	✓ 1.1 / 10.2 / 10.3 / 10.4 /	✓ 2.1	✓ 1.1 general	✓ 1.2.1	✓ 1.0, 1.1 compliance with legislation is part of COP compliance	✓ Introduction: any applicable legislation stricter than EurepGAP must be complied with	✓ P 1 general	X	X
C 5.2 No burning as part off land clearing or waste disposal	✓ 9.4 / 10.2	✓ 5.5	✓ 3.2.3 no fire for land clearing 3.4.1 avoid burning of waste	✓ 1.2.1	✓ Covered by compliance with Air COP	X	X	X	✓ 2.2.2 restricted to the minimum

P6. Workers rights and working relationships																		
C 6.1 Compliance with national laws concerning working conditions and workers rights	✓	P 5 (ILO, Un. Decl. of Human Rights and Children's right convention) 5.1 Complying with labour laws and internat. Agreements	✓	2.1	✓	1.1 / 4.2.1	✓	1.2.1	X		✓	Introduction: any applicable legislation stricter than EurepGAP must be complied with	✓	P 1 general	✓	9.1 general	P	Recommendation all ILO conventions and UN Charter of Rights for children
C 6.2 Contracts	✓	5.3	X		X		X		X		X		X		X		P	8. Recom.
C 6.3 Provision of information	✓	5.1 / 5.13	✓	1.1 / 6.2	✓	4.2.1	X		X		X		X		✓	9.1	X	
C 6.4 Subcontracting	✓	1.8 / 5.3	X		X		✓	1.9 (1.2.6)	P	9.0 not related to working conditions but to the requirements of	X		X		✓	9.6 till 9.9	X	
C 6.5 Freedom to associate and bargain	✓	5.12	✓	6.6	✓	4.2.2 ILO (87 & 98)	X		X		X		✓	4.3 as outlined in ILO	✓	4.1 4.2 4.3	✓	8.4
C 6.6 Child labour	✓	5.8 / 5.9	✓	6.7 no Child labour, except on fam. Farm without interfering with school	✓	4.3.1 No child labour, min 15 under 18 no hazardous work. Child on family farm, without skipping school	X		X		X		X		✓	1.1 , 1.2 1.3 1.4 should provide school + no longer than 10 hours (school, work and transport)	✓	8.6
C 6.7 Young workers (15-17)	✓	5.8	X		✓	4.3	X		X		X		X		✓	1.3 1.4	X	
C 6.8 Health and Safety	✓	5.14 (housing) / 5.15 (water quality) / 5.16 (medical services) / P6 (health and safety)	✓	4.7 health and safety plan 4.8 training	✓	4.3.2 health and safety policy 4.3.3 training	X		P	2.7.1	✓	1.4	✓	4.2 meet all applicable law and regulation covering health and safety of employees + families	✓	3.1 till 3.6 shall point out a responsible, provide trainings, clean bathrooms and dormitories	P	8. Recom.
Principles and Criteria	SAN/RA		RSPO		Basel		LEAF		ACCS		EurepGAP IFA		FSC		SA8000		IFOAM	
C 6.9 Wages	✓	5.4 / 5.5	✓	6.5 at least legal min. standards and sufficient to meet basic needs	✓	4.2.1 at least min wages and adequate standard of living	X		X		X		X		✓	8.1 8.2 min standards and sufficient to meet basic needs, no deductions for disciplinary purposes	P	8. Recom.
C 6.10 Discrimination	✓	5.2	✓	6.8, 6.9	✓	4.2.3 equality for all employees and contractors	X		X		X		X		✓	5.1 5.2 5.3	✓	8.5
C 6.11 Forced labour	✓	5.1	X		✓	4.3.1 No forced labour	X		X		X		X		✓	2.1 no support forced labour, nor should personnel be required to lodge deposits or identity papers	✓	8.3
Recommendations																		
C 6.12 Working hours	✓	5.6 working hours must not exceed legal maximum or ILO 5.7 Overtime	X		X		X		X		X		X		✓	7.1 max 48 h /wk	X	
P 7 Land right issues and community relations																		
C 7.1 Land right issues	✓	P7 Community relations	✓	2.2right to use land can be demonstrated 2.3 landuse not diminish legal rights other users 7.5 7.6		4.4.1 right can be demonstrated and local interpretations on land right should be identified	P	8.3.7	X		X		✓	2.1 till 2.3 / 3.1 till 3.3	X		P	8. Recom.
C 7.2 Consultation and communication local stakeholders	✓	P7 Community relations	✓	1.1 / 2.3 / 6.2 / 6.3 / 6.4	✓	4.1.2.	✓	1.10	X		X		✓	4.4	P	9.12 communication, but no consultation	X	

Auditing quality

The standards considered for recognition by the RTFO have been benchmarked to compare the controls around audit quality. The quality of the audit is equally as important as the depth and scope of the standard. If a standard covers all relevant sustainability criteria but has poor audit procedures, actual compliance with the sustainability criteria remains uncertain. The full benchmarking results are shown in the table below.

The main conclusions of this benchmarking are:

- Nearly all standards require certified farms to be visited at least once a year.
  - The SA8000 standard audit process allows surveillance audits between full audits, which is standard auditing practice.
  - Risk-based auditing is currently allowed by IFOAM (where high-risk farms might be visited more than once per year and low-risk farms less), again this is standard auditing practice. LEAF is considering introducing risk-based auditing for small-scale farms.
- When setting auditor competency requirements, the requirements vary but appear clear and appropriate. FSC and IFOAM actively comply with ISO19011.
- All certification must be carried out by accredited certification bodies, with the exception of a few LEAF marque certifications where the accreditation cost would not be proportional
- Accreditations for all standards, except SA8000, are made against ISO 65 (EN 45011) often with modifications to make the accreditation context specific. SA8000 has its own rigorous accreditation process.
- All standard organisations must have a rigorous system to ensure that audits are carried out to a sufficient quality, with the exception of LEAF which does not have a mechanism to review the quality of audits not carried out by a non-accredited body.

Table 10 – Benchmark results auditing quality

Standards	How many certification bodies are accredited to use the standard?	How often do audits need to be carried out?	Do all farms need to be audited?	What is the required competence of auditors?	What percentage of verification is carried out by nationally accredited organisations (such as by UKAS)?	What is required for certification bodies to be accredited to audit against your standard?	How do you retrospectively ensure audits are carried to the required standard?
Basel	The standard is currently being developed						
LEAF	5 (~40 auditors are approved).	Yearly	Yes. In the future it might be able to bundle small farms, particularly for small African farms where incomes are low and certification costs are prohibitive.	The qualifications for the baseline schemes (i.e ACCS red tractor) on the farm, plus a training day with LEAF. At least one auditor must be LEAF Marque trained.	About 90% of audits be carried out by UKAS accredited certification bodies. Of the five certification companies approved, two are UKAS accredited and the other three are in the process of accreditation.	The Certification body must demonstrate that its understands LEAF Marque's requirement specifications and audit requirements, and must be accredited to ISO 65 (EN 45011) for LEAF MaRque Scope. For justified reasons, such as where the accreditation cost would be not proportional, reduced accreditation requirements can be accepted.	UKAS oversees the quality of audits for baseline schemes.

Standards	How many certification bodies are accredited to use the standard?	How often do audits need to be carried out?	Do all farms need to be audited?	What is the required competence of auditors?	What percentage of verification is carried out by nationally accredited organisations (such as by UKAS)?	What is required for certification bodies to be accredited to audit against your standard?	How do you retrospectively ensure audits are carried to the required standard?
The Forest Stewardship Council (FSC)	15	Yearly. There are, however, reduced auditing rates for small and low intensity managed forests.	Yes	Auditor requirements comply with ISO19011 (which includes at least 5 years work experience and 40 hours of audit training; Lead Auditors must have completed three complete audits for a total of 15 days of audit experience under the direction and guidance of a Lead Auditor).	FSC accredits organisations.	Certification bodies must comply with ISO 65 and the additional requirements of the FSC (see out in FSC-STD-20-001). Accreditation Services International accredits the certification bodies on behalf of FSC.	FSC surveillance audits are conducted at least annually, as per ISO 65. Surveillance audits can be unannounced.
Roundtable On Sustainable Palm Oil (RSPO)	The standard is currently being developed						

Standards	How many certification bodies are accredited to use the standard?	How often do audits need to be carried out?	Do all farms need to be audited?	What is the required competence of auditors?	What percentage of verification is carried out by nationally accredited organisations (such as by UKAS)?	What is required for certification bodies to be accredited to audit against your standard?	How do you retrospectively ensure audits are carried to the required standard?
SA8000	14	Certification audits are carried out every 3 years, with surveillance audits every 6 months.	Yes	Social Accountability International (SAI) sets out minimum requirements for training and qualification of SA8000 auditors. However, each certification body determines their own qualifications.	SAI accredits organisations.	The accreditation process includes documentation review, site audits, and observation of auditors in the field by SAI. Ultimately, recommendation for accreditation is determined by a three-member panel from the SAI Advisory Board, including one staff member, one NGO or trade union representative and one business representative.	SAI has an oversight system in place to ensure audits are carried out sufficiently well. Each certification body is accredited for three years. Throughout that three year cycle, SAI will conduct a minimum of two surveillance audits per year, including office and witness audits, with the number increasing as the number of SA8000 certifications increase. At the end of the three year cycle, the certification body must undergo reaccreditation.

Standards	How many certification bodies are accredited to use the standard?	How often do audits need to be carried out?	Do all farms need to be audited?	What is the required competence of auditors?	What percentage of verification is carried out by nationally accredited organisations (such as by UKAS)?	What is required for certification bodies to be accredited to audit against your standard?	How do you retrospectively ensure audits are carried to the required standard?
Sustainable Agriculture Network (SAN) / Rainforest Alliance (RA)	None – Auditors are hired by the SAN. For-profit certifiers are not accredited.	Yearly	Yes	The SAN auditors are trained through a formal program managed by the Rainforest Alliance. This Programme includes week-long course, which combines field and classroom exercises in order to participate in an audit as a junior inspector. They must then participate in enough audits so that their coach is assured that that can serve as a lead auditor. All auditors must go through specialised or 'brush-up' courses at least once a year.	None	Rainforest Alliance works to ISO 65 certification (in the Sustainable Agriculture Program).	Every report is reviewed by experts in the secretariat. This quality control exercise is to ensure that auditors are correctly interpreting the standards and issuing consistent results farm-to-farm and country-to-country.

Standards	How many certification bodies are accredited to use the standard?	How often do audits need to be carried out?	Do all farms need to be audited?	What is the required competence of auditors?	What percentage of verification is carried out by nationally accredited organisations (such as by UKAS)?	What is required for certification bodies to be accredited to audit against your standard?	How do you retrospectively ensure audits are carried to the required standard?
Assured Combinable Crops Scheme (ACCS)	4 (more than 120 auditors are approved)	Routine audits are carried out once in every crop cycle prior to harvest (i.e. once every year) and there can be a minimum of six months or a maximum of 18 months between assessments because ACCS try to vary the time of year each assessment is made, so that they can assess conditions at different times of the year and crop cycle.	Yes	As a minimum, assessors of the AFS Combinable Crop standards must have: - a minimum of 5 years experience in agriculture relevant to combinable crops; - completed the Training Course for the NPTC certificate of Competence in Farm Inspection (Combinable Crops)* within 3 months of beginning assessments; - successfully passed the NPTC Farm Inspection (Combinable Crops) Course, or equivalent within 6 months of beginning assessments. Qualifications in the following are also desirable: - Auditing - Food Hygiene - HACCP	100%	First, certification bodies have to be accredited to ISO65 (EN45011). Then, they must obtain an extension of scope under ISO65 (EN45011) accreditation for the AFS ACCS Combinable Crops standards.	UKAS carries out an annual surveillance visit at each of the certification bodies licensed to audit to the standards. This involves a check of all the procedures and a shadow audit. ACCS send out a post-audit questionnaire sent to producers. ACCS also carry out spot checks and have a complaints and rejections procedure which receivers use to notify us of any problems with deliveries of crops etc. Problems are investigated.

Standards	How many certification bodies are accredited to use the standard?	How often do audits need to be carried out?	Do all farms need to be audited?	What is the required competence of auditors?	What percentage of verification is carried out by nationally accredited organisations (such as by UKAS)?	What is required for certification bodies to be accredited to audit against your standard?	How do you retrospectively ensure audits are carried to the required standard?
EurepGAP IFA	About 100 (more than 1000 auditors are approved)	Yearly	Yes	Lead Auditors must have tertiary qualification (or equivalent), have attended a recognised Lead Auditor training course (37 hours minimum), and have practical experience of ISO9000 or IS14000 (15 days minimum).	100%	All Certification Bodies that have received ISO Guide 65 (EN 45011) accreditation to the scope of EurepGAP 'Integrated Farm Assurance'.	Accreditation bodies operate surveillance system that complies with ISO Guide 65 (EN45011).
International Federation of Organic Agriculture Movements (IFOAM)	59	Normally yearly. Audits could be more/less frequent if farms are viewed as high/lower risk by the certification body. Comprehensive audits are required at least every three years.	No, audits can be risk-based .	Auditor requirements comply with ISO19011 (which includes at least 5 years work experience and 40 hours of audit training; Lead Auditors must have completed three complete audits for a total of 15 days of audit experience under the direction and guidance of a Lead Auditor). Auditors must be rotated at least every five years.	The International Organic Accreditation Service (IOAC) accredits certification bodies for IFOAM. For accreditation, a 5-10 day audit is carried out, which involves office audits, shadowing of audits and interviews with producers.	Accreditations are carried out against IFOAM's accreditation criteria, which is based on ISO65. The accreditation criteria ISO65 has been adapted to meet the requirements of the organic industry.	Surveillance audits are conducted as part of a planned programme. At least two surveillance audits will be carried out within each four yearly cycle, after which full reaccredidation is required.

Annex D: Guideline on definition of idle land

Displacement effects are considered a significant risk to the sustainability of biofuel production. By producing biofuel feedstock on idle land, displacement effects are prevented. Companies are encouraged to report the volumes of fuel which they have sourced from plantations on previously idle land in their annual reports. For the purpose of the RTFO the following guideline is used for the definition of "idle land".

Idle land is land which meets the following criteria:

- Compliance with all criteria of the RTFO Sustainable Biofuel Meta-Standard on Carbon storage (criterion 1.1), i.e.no destruction of large carbon stocks may have taken place.
- Compliance with all criteria of the RTFO Sustainable Biofuel Meta-Standard on Biodiversity (criteria 2.1/2.3), i.e. no conversion in or near areas with one or more High Conservation Values.
- Compliance with all criteria of the RTFO Sustainable Biofuel Meta-Standard on land rights and community relations (criteria 7.1/7.2), i.e. no violation of local people's rights.
- On 30-11-2005, the land was not used for any other significant productive function, unless a viable alternative for this function existed and has been applied which does not cause land-use change which is in violation with any of the criteria for 'idle land'.

Annex E: Example records for Chain of Custody

Table 11 – Example of an output record from a Farm supplying certified rapeseed to crusher C1[23].

Order Number	Transaction date	Receiving Company	Quantity (tonne)	Product	Product Origin	Env. Standard	Social Standard	Land use in Nov 2005	Crop yield (t/ha)	Nitrogen fertiliser (kg/ha)
22001	15-4-2008	C1	1,000	Rapeseed	UK	LEAF	Mechanised. + LEAF	Cropland	3.0	180

Table 12 – Example of an input record from a rapeseed crusher which takes in certified rapeseed from farm F1 and F2 and non-certified rapeseed from farm F3.

Order Number	Transaction date	Supplying company	Quantity (tonne)	Product	Product Origin	Env. Standard	Social Standard	Land use in Nov 2005	Carbon intensity (g CO_2e / tonne)
22001	15-4-2008	F1	1,000	Rapeseed	UK	LEAF	Mechanised. + LEAF	Cropland	949
22002	15-4-2008	F2	1,000	Rapeseed	UK	LEAF	Mechanised. + LEAF	Cropland	987
22001	15-4-2008	F3	1,000	Rapeseed	UK	-	-	Cropland	987

Table 13 – Example record of crusher conversion factor

Name conversion factor	Rapeseed to rapeseed oil
Input	Rapeseed
Output	Rapeseed oil
Unit	kg rapeseed oil / kg rapeseed
Value	0.40
Valid from	1-1-2008
Valid until	1-6-2008

23 Note: a farmer (or any other supply chain actor) has the option of passing either raw data or a calculated carbon intensity figure along the chain. In this example the farmer has chosen to provide raw data for crop yield and nitrogen fertiliser application rate – the oilseed crusher must then use default values for the remaining inputs to the carbon intensity calculation.

Table 14 – Example of an output record from a crusher supplying certified rapeseed oil to biofuel producer B. RSO stands for rapeseed oil.

Order Number	Transaction date	Receiving Company	Quantity (tonne)	Product	Product Origin	Env. Standard	Social Standard	Land use in Nov 2005	Carbon intensity (g CO_2e / tonne)
23001	20-4-2008	B	400	RSO	UK	LEAF	Mechanised. + LEAF	Cropland	2287
23002	20-4-2008	B	400	RSO	UK	-	-	Cropland	2287

Table 15 – Example of an input record from a biofuel producer which takes in certified rapeseed oil from crusher C1.

Order Number	Transaction date	Supplying company	Quantity (tonne)	Product	Product Origin	Env. Standard	Social Standard	Land use in Nov 2005	Carbon intensity (g CO_2e / tonne)
23001	20-4-2008	C1	400	RSO	UK	LEAF	Mechanised. + LEAF	Cropland	2287
23002	20-4-2008	C1	400	RSO	UK	-	-	Cropland	2287

Table 16 – Example of an inventory record of C&S data for crusher C1.

Product	Product Origin	Env. Standard	Social Standard	Land use in Nov 2005	Carbon intensity (g CO_2e / tonne)	Inventory (tonne) 15-4-2008	Input (tonne)	Output (tonne)	Inventory (tonne) 15-5-2008
RSO eq	UK	LEAF	Mechanised. + LEAF	Cropland	2287	1,000	800	400	1,400
RSO eq	Romania	-	-	Cropland	2287	2,000	0	0	2,000
RSO eq	UK	-	-	Cropland	2287	0	400	400	0

Table 17 – Example an input record from biofuel company B who takes in several batches of vegetable oil.

Order Number	Transaction date	Supplying company	Quantity (tonne)	Product	Feedstock Origin	Env. Standard	Social Standard	Land use in Nov 2005	Carbon intensity (g CO_2e / tonne)
22001	20-4-2008	C1	1,200	RSO	UK	LEAF	Mechanised. + LEAF	Cropland	2287
22002	20-4-2008	C1	4,800	RSO	Unknown	-	-	Unknown	2287
22005	20-4-2008	C2	400	CPO	Malaysia	RSPO	RSPO	Cropland	1343
22006	20-4-2008	C2	600	CPO	Malaysia	-	-	Unknown	1343

Table 18 – Example of an output record from biofuel company B who supplies 2,000 tonnes biodiesel to oil major X, of which 400 tonnes meet an accepted standard.

Order Number	Transaction period	Receiving company	Quantity (tonne)	Fuel type	Feedstock	Feedstock Origin	Env. Standard	Social Standard	Land use in Nov 2005	Carbon intensity (g CO_2e / tonne)
33001	4-2008	X	300	Biodiesel	RSO	UK	LEAF	Mechanised + LEAF	Cropland	2894
33002	4-2008	X	1,400	Biodiesel	RSO	Unknown	-	-	Unknown	2894
33005	4-2008	X	100	Biodiesel	PO	Malaysia	RSPO	RSPO	Cropland	1861
33006	4-2008	X	200	Biodiesel	PO	Unknown	-	-	Unknown	1861

Table 19 – Example of an input record from oil major X who receives 2,000 tonnes biodiesel from biodiesel producer B, of which 400 tonnes meet an accepted standard.

Order Number	Transaction period	Supplying company	Quantity (tonne)	Fuel type	Feedstock	Feedstock Origin	Env. Standard	Social Standard	Land use in Nov 2005	Carbon data (g CO_2e / tonne)
33001	4-2008	B	300	Biodiesel	RSO	UK	LEAF	Mechanised + LEAF	Cropland	2894
33002	4-2008	B	1,400	Biodiesel	RSO	Unknown	-	-	Unknown	2894
33005	4-2008	B	100	Biodiesel	PO	Malaysia	RSPO	RSPO	Cropland	1861
33006	4-2008	B	200	Biodiesel	PO	Unknown	-	-	Unknown	1861

Annex F: Assessing carbon intensity and calculating direct GHG saving

This Annex briefly summarises how to assess the carbon intensity of an administrative batch of biofuel in order to submit carbon data for monthly reports. Further details on assessing carbon intensity are provided in the background document *Carbon Reporting – Default values and fuel chains*.

The carbon intensity of a batch of biofuel can be assessed by:

- Collecting information about the way in which it was produced in order to calculate a "known" carbon intensity
- Selecting an appropriate "fuel chain default value" based on qualitative information about the fuel

Calculating a known carbon intensity

Information about activities which take place during the production of a biofuel can be used to calculate its carbon intensity. The information collected could be either:

- Quantitative **"actual data"** about inputs used during the production of a biofuel – for example, that 9,000 MJ of natural gas are used for every tonne of bioethanol produced.
- Qualitative data about processes used during the production of a biofuel – for example, that the biofuel plant uses biomass to provide heat and power. This qualitative data enables the use of **"selected defaults"** – default values derived by the RTFO Administrator corresponding to the process described.

This information does not have to describe all of the processes involved in producing a biofuel – where it is not available default values defined by the RTFO Administrator can be used instead. Evidence will be required to support any use of such information – this is discussed in more detail in Section 6.

The known carbon intensity value calculated using the procedures set out in the background document *Carbon Reporting – Default values and fuel chains* is reported in a supplier's monthly C&S report.

There is a large amount of data companies could collect in order to derive a known carbon intensity. However, only a small number of data points can have a significant influence on the final carbon intensity of a biofuel. Table 20 highlights the data points which have the most influence on final carbon intensity and which should be the focus of data collection efforts.

Table 20 – Focus for data collection

Step in the supply chain	Focus for data collection
Crop production	Nitrogen fertiliser application rate Crop yield & moisture content Fuel consumption for cultivation
Feedstock and liquid fuel transport	Transport distances
Conversion – either biofuel conversion or oilseed crushing	Yield[24] Fuel demand Electricity demand Co-product treatment

Fuel chain default values

When information about how a biofuel was produced is not available, a fuel chain default value must be used in order to report its carbon intensity. Different types of fuel chain default values are available based on the information which is known about the fuel. The type of fuel chain default value that can be used depends on what is known about:

- The feedstock used to produce the fuel, and
- The country the feedstock originated from.

Table 21 summarises which fuel chain default values can be used on the basis of the information that is known and provides a cross reference to the default value tables below. The appropriate default value selected from the tables below is then reported in a supplier's monthly C&S report.

Table 21 – Cross-reference to relevant default value table

Origin	Feedstock	Type of default value	Default value table
Unknown	Unknown	Fuel	Table 22
Unknown	**Known**	Feedstock	Table 23
Known	**Known**	Feedstock & Origin	Table 24

24 i.e. tonnes of product (e.g. biodiesel) per tonne of input (e.g. rapeseed oil)

Default value tables

Table 22 – Fuel default values

Fuel	Carbon Intensity grams CO_2e / MJ
Bioethanol	78
Biodiesel	77
Biomethane	36
Bio-ETBE	42

Table 23 – Feedstock default values

Fuel	Feedstock	Carbon Intensity grams CO_2e / MJ
Bioethanol[25]	Wheat	78
	Sugar beet	51
	Corn	125
Biodiesel	Oilseed rape	77
	Soy	59
	Palm	51
	UCO & tallow	14
Biomethane	MSW & manure	36
ETBE – refinery isobutene	Wheat	17
	Sugar beet	5
	Sugar cane	30
	Corn	42
ETBE – imported isobutene	Wheat	30
	Sugar beet	56
	Sugar cane	78
	Corn	51

25 Note that note that no feedstock default value is given for ethanol produced from sugar cane. If a fuel supplier is importing ethanol which has been produced from sugar cane, but the origin of the feedstock is not known, they will have to use the **fuel default** for ethanol or establish the origin of the feedstock.

Table 24 – Feedstock & origin default values

Fuel	Feedstock	Origin	Carbon Intensity grams CO_2e / MJ
Bioethanol	Wheat	Canada	104
		France	83
		Germany	77
		United Kingdom	78
	Sugar beet	UK	51
	Sugar cane	Brazil	20
	Corn	US	125
		France	62
Biodiesel	Oilseed rape	Australia	78
		Canada	77
		France	67
		Germany	69
		Poland	66
		United Kingdom	77
	Soy	Argentina	22
		Brazil	59
		USA	32
	Palm	Malaysia	51
		Indonesia	51
	UCO & tallow	UK	14
Biomethane	MSW or manure	UK	36
ETBE – refinery isobutene	Wheat	Canada	24
		France	17
		Germany	14
		United Kingdom	15
	Sugar beet	UK	5
	Sugar cane	Brazil	-6
	Corn	US	30
		France	9

Fuel	Feedstock	Origin	Carbon Intensity grams CO_2e / MJ
ETBE – imported isobutene	Wheat	Canada	50
		France	42
		Germany	40
		United Kingdom	40
	Sugar beet	UK	30
	Sugar cane	Brazil	19
	Corn	US	56
		France	34

What to do if there is no appropriate default value

There may be certain situations in which an appropriate default value is not available for a batch of biofuel – for example, when a biofuel produced from a new feedstock (e.g. biodiesel from jatropha) or a new type of fuel is imported into the UK. Industry should advise the RTFO Administrator of biofuels which are introduced into the UK in significant quantities and for which default values are not available. If the RTFO Administrator is advised of such a situation, they should establish a process to determine appropriate default values for the new fuel chain.

While a new default value is being established, the RTFO Administrator will assign a temporary default value. Temporary default values should be set on one of the following basis:

- At a level which represents the average carbon intensity for that type of biofuel – where the biofuel is produced from a new feedstock. For example, the temporary default value for bioethanol from miscanthus would be set equal to an average of the bioethanol already supplied into the UK.
- At a level which represents the average carbon intensity for biofuels produced from that feedstock – where the biofuel is a new fuel type, produced from an existing feedstock (e.g. biobutanol produced from sugar beet).
- At a level which represents the typical carbon intensity of all biofuels regardless of fuel type or feedstock – where the biofuel is a new fuel, produced from a new feedstock.

Temporary default values will be valid until such time as a new value has been established and approved by the RTFO Administrator.

Calculating direct GHG saving.

The direct GHG savings of a biofuel are established by comparing the biofuel's carbon intensity against the displaced fossil fuel's carbon intensity. This comparison must be done using carbon intensity values given on an energy basis i.e. grams CO_2e / MJ. For all fuels it is assumed the energy efficiency (i.e. kilometres per MJ) of vehicles is the same and, therefore, that 1 MJ of biofuel displaces 1 MJ of fossil fuel.

The direct GHG saving (as a percentage) is calculated using the following formula:

$$\text{GHG saving} = \frac{\text{Carbon intensity of fossil fuel displaced} - \text{Carbon intensity of biofuel}}{\text{Carbon intensity of fossil fuel displaced}} \times 100$$

Note that a negative result denotes an increase in GHG emissions

The carbon intensities of fossil fuels are as follows:

- Gasoline: 84.8 grams CO_2e / MJ
- Diesel: 86.4 grams CO_2e / MJ
- Natural gas: 62.0 grams CO_2e / MJ
- MTBE: 84.7 grams CO_2e / MJ

Example: Ethanol replaces gasoline

A fossil fuel company blends ethanol produced from UK sugar beet with gasoline. The percentage GHG saving is calculated as follows:

Carbon intensity of biofuel = 50 g CO_2e / MJ

Carbon intensity of gasoline = 84.8 g CO_2e / MJ

$$\text{GHG saving} = \frac{84.8 - 50}{84.8} \times 100 = 41.0\%$$

Exception: Bio-ETBE produced using refinery isobutene

The only exception to the above approach is when the biofuel which is being considered is bio-ETBE **<u>that has been produced using isobutene which is a by product of oil refining</u>**. In this case the following formula is used to calculate the GHG saving (the rationale for the difference in approach is explained in *Carbon reporting within the RTFO: Methodology*).

$$\text{GHG saving} = 1 - \frac{\text{Carbon intensity of bioETBE}}{\text{Carbon intensity of MTBE}} \times (100)$$

Example: Bio-ETBE replaces gasoline

A fossil fuel company blends bio-ETBE produced from Brazilian ethanol (using oil refinery isobutene) with gasoline. The percentage GHG saving is calculated as follows:

Carbon intensity of bioETBE = -7 g CO_2e / MJ

Carbon intensity of MTBE = 84.7 g CO_2e / MJ

$$\text{GHG saving} = 1 - \frac{-7}{84.7} \times 100 = 108\%$$

Note that, for all types of bio-ETBE, the volume which this saving can be reported alongside is only the volume which is defined as renewable for the purposes of the RTFO.

Annex G: Assessing the impact of land use change

This Annex summarises how to report on land use and how to assess the impact of any changes in land use on the carbon intensity of an administrative batch of biofuel.

Land use in 2005

The RTFO Administrator will monitor both direct and indirect changes in land use. Fuel suppliers must therefore report on how the land used to produce a biofuel was being used in November 2005. Table 25 describes the different land use categories which exist.

Table 25 – Land use type definitions

Land use	Description
Cropland	This category includes cropped land, including rice fields, and agro-forestry systems where the vegetation structure falls below the thresholds used for the Forest Land category. Including set-aside – provided it has not been set aside for more than 5 years.
Forest land	Land spanning more than 0.5 hectare with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural (or urban) land use.
Grassland (and other wooded land not classified as forest) with agricultural use	This category includes rangelands and pasture land that are not considered Cropland but which have an agricultural use. It also includes systems with woody vegetation and other non-grass vegetation such as herbs and brushes that fall below the threshold values used in the Forest Land category and which have an agricultural use. It includes extensively managed rangelands as well as intensively managed (e.g., with fertilization, irrigation, species changes) continuous pasture and hay land.
Grassland (and other wooded land not classified as forest) without agricultural use	This category includes grasslands without an agricultural use. It also includes systems with woody vegetation and other non-grass vegetation such as herbs and brushes that fall below the threshold values used in the Forest Land category and which do not have an agricultural use.

Default values

Table 26 provides a list of default values which can be used in monthly reports based on what is known about:

- Land use in 2005
- Type of biofuel cropland (annual or perennial)
- Country in which land use change has occurred.

Table 26 – Impact of changes in land use on carbon intensity (tonnes CO_2e / hectare)

Country	Land use in November 2005			
	Forest land		Grassland	
	Annual cropland	Perennial cropland	Annual cropland	Perennial cropland
Argentina	13.7	7.4	1.7	0.0
Australia	18.1	11.8	1.7	0.0
Brazil	29.2	17.6	7.6	2.6
Canada	13.9	7.8	1.7	0.0
France	14.2	6.4	3.4	0.0
Germany	16.4	6.9	5.2	0.2
Indonesia	29.2	17.6	7.6	2.6
Malaysia	29.2	17.6	7.6	2.6
Poland	16.4	6.9	5.2	0.2
United Kingdom	20.8	11.3	5.2	0.2
USA	13.9	7.8	1.4	0.0

Note: the impact of land use change is amortised over a 25 year period. Full details on this and other the assumptions made in calculating these default values are available in *Carbon reporting within the RTFO: Methodology*

The default values in Table 26 are given in units of tonnes (of CO_2e emissions) per hectare, for monthly reports these values must be converted to grams per MJ of biofuel. To complete this conversion carry out the following steps (using either a default value or actual data):

- Divide the impact of land use value from Table 26 by the feedstock crop yield.
- Divide the result by all conversion plant yields (e.g. oilseed crushing plant and biofuel plant yields).
- Multiple the result by any allocation factors given in conversion plants.

- Convert the result from a weight basis to an energy basis using the lower heating values given in *Carbon Reporting – Default values and fuel chains*.

For example: If Brazilian soy is produced on land which was forested land in November 2005, the appropriate default value from Table 26 is 729 t CO_2e / hectare. This value is converted to grams per MJ by:

- Dividing by the default value by the soy yield:
  - 29.2 / 2.5 = 11.68 t CO_2e / t soy
- Dividing the result by the soy crushing conversion yield:
  - 11.68 / 0.17 = 68.7 t CO_2e / t soy oil
- Dividing the result by the biodiesel conversion yield:
  - 68.7 / 0.95 = 72.3 t CO_2e / t biodiesel
- Multiplying by the biodiesel conversion allocation factor
  - 72.3 x 99% = 71.6 t CO_2e / t biodiesel
- Dividing the result by the lower heating value of biodiesel
  - 71.6 / 37,200 = 0.001925 t CO_2e / MJ biodiesel
- Converting the result from tonnes to grams of CO_2e
  - 0.04735 x 1,000,000 = **1,925** grams CO_2e / MJ biodiesel

The figure 1,925 is provided in the monthly report in the column ‘impact of land use’

If more detailed information is known (e.g. soil types, climate zones etc) then more accurate calculations can be carried out using the more advanced approaches set out in the IPCC guidelines for assessing the impact of land use change.

Calculating carbon payback time

Carbon payback time is calculated by dividing by the amount of carbon which is saved by the type of biofuel which will be grown on the converted land. The amount of carbon saved is calculated by subtracting the appropriate fuel & origin default value (given in Table 24) from the carbon intensity of the fossil fuel which is displaced, which are as noted below. This comparison must be done using carbon intensity values given on an energy basis i.e. grams CO_2e / MJ. For all fuels it is assumed the energy efficiency (i.e. kilometres per MJ) of vehicles is the same and, therefore, that 1 MJ of biofuel displaces 1 MJ of fossil fuel

- Gasoline: 85 grams CO_2e / MJ
- Diesel: 86 grams CO_2e / MJ
- Natural gas: 62 grams CO_2e / MJ

From the example above the impact of land use change is 1,925 grams CO_2e / MJ biodiesel and the carbon intensity of biodiesel from Brazilian Soy in Table 24 = 59 grams CO_2e / MJ.

The amount of carbon saved is therefore:

- 86 – 59 = 27 CO_2e /MJ

The carbon payback time is $=\frac{1{,}978}{27}=71 years$

In addition to reporting the carbon intensity of an administrative batch of biofuel, suppliers must also report on what "type" of data has been used to derive the carbon intensity which is reported – i.e. whether it is based on a fuel default, feedstock default, feedstock & origin default or whether qualitative or quantitative information was used. This information will be used by the RTFO Administrator mainly to understand whether or not companies are collecting actual data about how a biofuel has been produced and will an indication of the accuracy of the reported carbon intensities.

Each type of data is attributed a certain accuracy level, based on the amount of effort a company would have to put into data collection. Table 27 shows the accuracy levels which should be reported for administrative batches.

Table 27 – Accuracy levels corresponding to type of default value or data used

Type of default value or data	Accuracy level
Fuel default	0
Feedstock default	1
Feedstock & origin default	2
Selected default	3
Actual data	4

Selected defaults or actual data

Scores of 3 or 4 can only be awarded for use of qualitative of quantitative data for data points which generally contribute 5 percent or more of the GHG emissions within a default fuel chain. These data points are given in Table 28. If a selected default is used for any of the data points specified then a score of 3 is given for that batch of fuel, if actual data is used then a score of 4 is given.

Annex H: Accuracy level

Table 28 – Data points which are eligible for accuracy level scores of 3 or 4.

Section of biofuel chain	Data points eligible for higher accuracy level
Crop production	Crop yield; nitrogen fertiliser application rate; nitrogen fertiliser emissions co-efficient; diesel use for cultivation
Drying and storage	Moisture removed during drying; amount of fuel used for heating
Feedstock transport	Distances and modes (where the default is greater than 300 kilometres by truck, or 1,500 km by ship)
Conversion	Process yield; amount of natural gas or other fuel used; emissions co-efficient of fuel used; amount of electricity used; all data related to co-products; amount of methanol used (biodiesel only); treatment of palm oil mill effluent
Other	Alternative waste treatment credit (biomethane and UCO & tallow to biodiesel only)

Combining batches

When two or more batches of fuel are combined[28] the new accuracy level is equal to:

- The accuracy level of the old batch which makes up more than 50% (by volume) of the new combined batch.

However, if none of the old batches make up 50% (by volume), then, the new accuracy level is equal to:

- The weighted-average (on a volume basis) of all of the old batches, rounded to zero decimal places.

28 Which can be done if they have identical sustainability characteristics.

Annex I: The Consultation criteria

This consultation has been produced in accordance with the principles of the Government's Code of Practice on Consultation.

The code of practice applies to all UK public consultations by government departments and agencies, including consultations on EU directives.

Though the code does not have legal force, and cannot prevail over statutory or other mandatory external requirements (e.g. under European Community Law), it should otherwise generally be regarded as binding unless Ministers conclude that exceptional circumstances require a departure.

The code contains six criteria. They should be reproduced in all consultation documents. There should be an explanation of any departure from the criteria and confirmation that they have otherwise been followed.

Consultation criteria

1. **Consult widely throughout the process, allowing a minimum of 12 weeks for written consultation at least once during the development of the policy.**
2. **Be clear about what your proposals are, who may be affected, what questions are being asked and the time-scale for responses.**
3. **Ensure that your consultation is clear, concise and widely accessible.**
4. **Give feedback regarding the responses received and how the consultation process influenced the policy.**
5. **Monitor your department's effectiveness at consultation, including through the use of a designated consultation co-ordinator.**
6. **Ensure your consultation follows better regulation best practice, including carrying out a Regulatory Impact Assessment if appropriate.**

A full version of the code of practice is available on the Cabinet Office web-site at: http://www.cabinet-office.gov.uk/regulation/consultation/code.asp

If you consider that this consultation does not comply with the criteria or have comments about the **consultation process** please contact:

Andrew D Price
Consultation Co-ordinator
Department for Transport
Zone 9/9 Southside
105 Victoria Street
London, SW1E 6DT

email: Consultation@dft.gsi.gov.uk

Annex J: List of those consulted

Active Business Partnerships
AEA Technology
Agricultural Development Advisory Service
Agricultural Industries Confederation
Air Products
Amenity, Environmental and Agricultural Industries
Architects and Engineers for Social Responsibility
Argent Energy
Arkady Feeds (UK) Ltd
ARCC Ltd
Arval/phh
ASDA
Association of UK Oil Independents (AUKOI)
Bath and North East Somerset Council
Bayer Crop Science
Bayford & Co. Ltd
Bioethanol Ltd
Biofuel Corporation plc
Biofuels Alliance
Bio-Power UK Ltd
Bioroute
BIOX Corporation
BIP (Oldbury) Ltd
Biscuit, Cake, Chocolate and Confectionery Association
Blackdown Biodiesel Ltd
Blooming Future Ltd
BMW (UK) Ltd
Bob Larbey Associates
BOC plc
BP plc

Bradford Biofuels
Bridgend Partners
British Edible Pulse Association
British Oat & Barley Millers Association
British Starch Industry Association
British Sugar
Broadlands Fuel
C H Jones
Cambridge University
Campaign to Protect Rural England
Carbon Trust
Cargill (Refined Oils)
Central Science Laboratory
Centre for Ecology & Hydrology
ChevronTexaco
CNG Services
Commission for Rural Communities
Concawe
Confederation of Forest Industries (UK) Ltd
Confederation of Passenger Transport
Conoco Phillips
Consols Oil
Co-operative Insurance Society
Corus Group
Country Land & Business Association
CPL Petroleum
Credit Suisse
Cremer Energy GmbH
C Ris Energy
C Zero Energy Ltd
D1Oil plc
DaimlerChrysler UK Ltd
DCS Energy Ltd
Defence Fuel Group
Deloitte & Touche LLP
Department for International Development
Department for Trade and Industry
Dunn Commodities Ltd

E4Tech
East Durham Biodiesel Ltd
East of England Development Agency
East of England Regional Biofuels Forum
Ebony Solutions
EcoVector Consulting
ECOTEC Rearch & Consulting Ltd
Edinburgh Centre for Carbon Management
Energy 21
Energy Saving Trust
English Farming and Food Partnerships
English Nature
Ensus Ltd
Envirogroup
Environment Agency
Environmental Industries Commission
Esso Plc
Euro Biodiesel Ltd
European Biodiesel Board
European Fuel Oxygenates Association
European Pure Plant Oils Association
ExxonMobil Petroleum & Chemical
Falmouth Oil Service Ltd
Farm Line
Farmers Link
FCL Biofuels
FCLCUK
Federation of Oils, Seeds & Fats Associations
Federation of Petroleum Suppliers Ltd
Fells Associates
Fleetsolve Ltd
Food & Drink Federation
Ford Fuel Oils Ltd
Ford Motor Company
Forecourt Equipment Federation
Forestry and Timber Association
Forestry Commission
Freight Transport Association

Friends of the Earth
Frontier Agriculture
Futura Petroleum
GasRec
Gemserv Ltd
General Motors UK
Gfleet Services Ltd
GLA (Greater London Authority)
Gloucestershire County Council
Government industry Forum on Non-Food Uses of Crops
Grain & Feed Trade Association (GAFTA)
Grainfarmers plc
Green Biodiesel Ltd
Greenergy
Greenpeace
Green-Ways
Hampshire County Council
Harvest Energy
Hingley & Callow
Home Grown Cereals Authority (HGCA)
Imperial College
Ineos
Infineum UK Ltd
Institue for Public Policy Research
Institute for European Environmental Policy
Int Fuel Quality Centre Biofuels
International Institute for Environment & Development
Iogen
Johnston Oils
Kuwait Petroleum
Kyoto Fuels
LACORS
Lincolnshire County Council.
Local Government Association
London Air Quality Steering Group
London Biofuels Plc
Longma Biofuel
Losonoco Ltd

Louis Dreyfus Trading Ltd
LowCVP
LP Gas Association
LSS Oil
Lubrizol
Lyondell
Mabanaft Ltd
Maltsters Association of Great Britain
Manchester Biodiesel Co-operative
Morgan Stanley
Morrison
Murco Petroleum Ltd
National Association of British & Irish Millers
National Audit Office
National Farmers Union
National Non-Food Crops Centre
Natural Alcohol Producers Association
NERC and BBSRC
Neste Oil
New and Renewable Energy Centre Ltd
NFU
NI Biofuels
Northeast Biofuels/ Teesside Chemical Initiative Ltd
Northern Ireland Executive
NSCA
Ofgem
OGCbuying Solutions
Oikos Storage
One Northeast
Organic Power Ltd/NGVA
Oxera
Oxfam
Petrochem UK Ltd/ Petrochem Carless Ltd
Petrol Retailers' Association
Petroplus
Prism Chemical
Product Board for Margarine, Fat & Oil
Quantock Energy & Environment (Qe^2)

RBS
Regenatec
Regional Development Agencies
Renew Tees Valley Ltd
Renewable East
Renewable Energy Association
Renewable Energy Management Ltd
Rix Biodiesel/JR Rix
Roquette UK Ltd
Rozone
RPS Conservation
RSPB
Sainsburys
Sandcroft Consultant
School of Environmental Sciences
Scottish Executive
Scottish Natural Heritage
Scottish Renewables
Scottish Rural Property and Business Association
Seed Crushers & Oil Processors Association (SCOPA)
SembCorp Utilities (UK) Ltd
Sempra Oil Trading Sarl
SenterNovem
Shell
SITA UK
Society of Motor Manufactuers and Traders
Soil Association
Solutions for Environment, Economy & Technology
Somerset County Council
Stroud District Council
Sustainable Development Commission
Sustainable Energy Action
Sustainable Environmental System Ltd
SW Biofuels
SW Seed
Talloil
Tees Valley Biofuels
Terra Nitrogen (UK) Ltd

Tesco
Thames Water
The Royal Society
Tibbio Biofuels
Total
Toyota Motor Europe
Tramp Oil & Marine
UK Maize Millers Association
UKERC
UKPIA
Uniqema Chemical Ltd
University of Abertay Dundee
VCA
V-Fuels Ltd
Volkswagen Group Ltd
Volvo
Vopak Terminal London BV Ltd
Waste Disposal Agency
Welsh Assembly
Wessex Grain
Wessex-Green Spirit Fuels/ Bio fuels
West Devon Council
Wheb Ventures
WWF
Yorkshire and Humber Regional Energy Forum

Part Two

Carbon Reporting – Default values and fuel chains

Introduction

This part of the document provides detailed information on the proposed process for calculating the carbon intensity of a batch of biofuel – for the purposes of reporting under the RTFO. It is intended as supplementary guidance to part one of the document.

1. This part of the document provides guidance on how to calculate a known carbon intensity. The following four ways of using information collected about the activities involved in producing a biofuel are described:

- Use of qualitative information to calculate a carbon intensity
- Use of quantitative data or actual data to:
  - Edit pre-defined (default) fuel chains
  - Make adjustments to the structure of existing fuel chains
  - Construct a new fuel chain

Using qualitative information to calculate a known carbon intensity

2. A number of "selected default values" have been defined to enable the use of qualitative data to calculate a known carbon intensity. For certain sources of GHG emissions qualitative information can be used to characterise different ways of producing the biofuel – for example the mode of transport (truck, ship, rail etc) or the fuel used in a biofuel plant (coal, natural gas, fuel oil etc). When companies have qualitative evidence to demonstrate that a batch of fuel is produced in a certain way (e.g. that a feedstock was transported by rail) they can use the appropriate selected default value.

What selected defaults are available?

3. Selected defaults are available to change the following options:

- Type of nitrogen fertiliser. This selected default can be used to calculate emissions from crop production.
- Type of phosphorus fertiliser (used in crop production). This selected default can be used to calculate emissions from crop production.

- Transport mode (e.g. truck, ship, rail etc). This selected default can be used to calculate emissions from transport of any type of product.
- Type of fuel used to provide heat (e.g. diesel, coal, heavy fuel oil, natural gas etc). This selected default can be used to calculate emissions in the following processes:
    - Drying of crops (drying and storage),
    - Oil crop crushing plants (conversion), and
    - Biofuel plants (conversion).
- Energy configuration – i.e. the processes by which heat is generated, e.g. a simple boiler or a CHP system. This selected default can be used to calculate emissions in the following processes:
    - Oil crop crushing plants (conversion), and
    - Biofuel plants (conversion).

How are selected defaults used?

4. Each default fuel chain includes a “Selected default options” table which summarises the selected defaults available for that particular fuel chain. To make use of a selected default:
    - Select the option desired.
    - Follow the procedures outlined in Section 0 to establish the known carbon intensity of the batch of fuel.

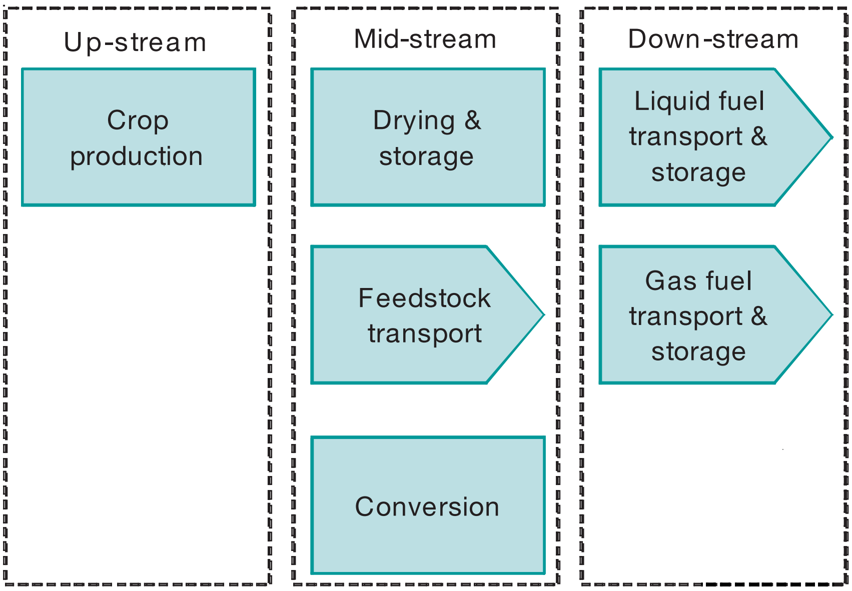
Editing pre-defined fuel chains with actual data

5. This section describes how to use actual quantitative data to calculate a carbon intensity (the procedures outlined here also apply to the use of data obtained from selected defaults) by editing an existing fuel chain. It does not describe how to make changes to the structure of the fuel chains (e.g. add new conversion or transport steps) – this is addressed below.
6. **NOTE:** An existing default fuel chain can only be edited when **both** the type of feedstock and its origin are known.

Structure of default fuel chains

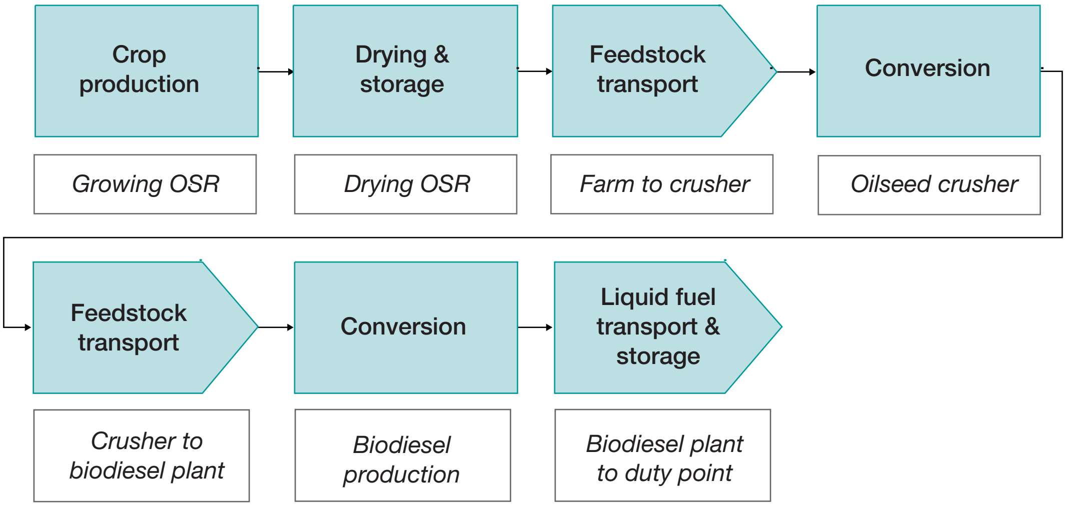
7. The fuel chains given later in this document are constructed by arranging common “modules” into a series of sequential stages. Figure 1 shows the common modules which make up every fuel chain and Figure 5-3 illustrates how they are arranged into a fuel chain.

Figure 1 Modules used to define a biofuel fuel chain



Module Name	Description
Crop production	Growing a biofuel feedstock (e.g. palm, wheat, soy etc)
Drying & storage	Drying and storage of biofuel feedstocks (where this is done outside of a biofuel conversion plant)
Feedstock transport	Transport of a biofuel feedstock (e.g. from a farm to a biofuel conversion plant)
Conversion	Any process which changes the physical nature of a feedstock or a biofuel (e.g. oilseed crushing, fermentation etc). The process will typically also result in the production of co-products (e.g. soy meal).
Liquid fuel transport & storage	Transport of a liquid biofuel (e.g. from a biofuel conversion plant to a refinery).
Gas fuel transport & storage	Transport of a gaseous biofuel (e.g. from a biofuel conversion plant to a refuelling point).

Figure 2 – Example fuel chain defined using common module



Validity of actual data over time

8. The actual data which can be used to edit a default fuel chain does not have to be "real-time" data (e.g. companies will not be required to assess conversion plant characteristics such as yield and natural gas use at the exact moment that a particular batch of biofuel is processed). Instead, all actual data in conversion modules can be based on characteristics averaged over a 12 month period.

Actual data for crop production

9. It will be permissible for evidence in support of actual data provided for crop production to take the form of a statistically accurate survey of farm level data. Such surveys would be considered valid for one crop growing season.

Editing a fuel chain

NOTE: if changes are to be made to how co-products are treated see below.

Step 1: **Select the appropriate default fuel chain to be edited based on the biofuel's feedstock type and origin.**

Step 2: Refer to the **compulsory linkages** section below to establish whether there are between the actual data to be used and any other data inputs. If there is such a link, actual data must be used for both data inputs.

Step 3: **In the appropriate module within the default fuel chain complete** all the data input fields in the module being edited using the available actual data. Complete the remaining fields in the module using default values obtained from the tables in the relevant section below. The default values in these tables are arranged by "country of origin" – care must be taken to ensure the correct values are used.

NOTE: Default values for "emission factors", which are generally in the second column of the module's data input fields, can be found in the General Default Values section.

NOTE: If the actual data which is known is not a specific data point, but is the carbon intensity of an entire product (e.g. wheat with 300 kg CO_2e/tonne or rapeseed oil with 850 kg CO_2e/tonne) it is not necessary to fill in the data input fields for the entire module. Instead, the known carbon intensity value should be inserted in the directly into the "Fuel Chain Summary" Table – see Step 5.[1]

Step 4: Perform all the required **calculations** (i.e. in the fields marked *"calculation"*) in the module. Formulas for the calculations are generally found immediately to the left of the calculation fields (some are immediately to the right). The numbers and letters given in formulas are "Field references" which are generally found immediately to the right of a field (some are given inside the field itself). Calculations should be performed working from the top left, to the bottom right – including the three "Total" fields at the very bottom.

Step 5: The "**Fuel Chain Summary**" table (which appears at the beginning of the relevant fuel chain) can now be updated with the new total for this module: identify the appropriate module in the "Fuel Chain Summary" table, and replace it with the "Contribution to overall fuel chain" field from the module which has just been recalculated.

Step 6: The new **fuel chain carbon intensity** can be calculated by summing all the rows given in the "Fuel Chain Summary" table for the specified country of origin – including the new value for the module which has been recalculated.

Step 7: For reporting to the RTFO Administrator, this value must be converted to carbon intensity per MJ – using the standard energy content values (lower heating values specified in the General Default Values section).

1 Note that, in this situation, default values for the other upstream stages are not required as these should have already been taken into account in the carbon intensity of the product which has been purchased.

Providing actual data on co-products

10. The impact of co-products must be taken into account when calculating a biofuel's carbon intensity. The approach taken depends on the co-product and its use. The default fuel chains address the main co-products. If a co-product must be addressed, where possible by using the substitution method is not listed then an approach must be selected based on the following rules (the approaches are described in more detail below):

    - Co-products must, where possible, be accounted for using the **substitution** approach.
    - The only exception is if one or more of the co-products are used for an energy end use (e.g. it is burnt to provide heat or to generate electricity) that is not in the conversion plant which produces it. In this case it must be accounted for using the **allocation by energy content** approach. Allocation by energy content is compatible with the substitution approach: the non-energy co-products are accounted for by substitution and do not form part of the allocation.
    - Where the data required to undertake the substitution approach is not available, the co-products may be accounted for using the **allocation by market value** approach. Allocation by market value is compatible with the substitution approach: co-products which have appropriate credit data available are accounted for by substitution and do not form part of the allocation.
    - Allocation by market value and allocation by energy content cannot be used simultaneously. If a conversion plant produces energy and non-energy co-products, and substitution data is not available for the non-energy co-products, the **allocation by market value** must be carried out.

11. If a co-product is not listed within the default fuel chains and it is likely to have a significant impact on the final carbon intensity of the biofuel (i.e. 10 percent or more relative to the carbon intensity of the fuel chain without this co-product) and it will be supplied for a period of 12 months or more then the approach taken must be discussed and agreed with the RTFO Administrator. For co-products which do not meet these criteria, verifiers will check that the above rules have been correctly applied.

Approach	Description of approach
Allocation by energy content	Step 1: Calculate the amount of energy (in MJ) being exported from the conversion plant in each of the co-product streams as well as for the main biofuel product.[2] Step 2: Calculate the total amount of energy (in MJ) exported from the plant (including energy contained within the biofuel and the co-products). Step 3: Divide the energy exported in the biofuel by the total amount of energy – this is the allocation factor, the proportion of emissions which should be allocated to the biofuel. Step 4: Multiply the emissions which occurred in this module and all upstream emissions by this allocation factor.
Substitution	Step 1: Identify the "marginal product" which is substituted as a result of the co-product entering the market. Step 2: Establish the carbon intensity of the marginal product[3]. Step 3: Establish the quantity of the marginal product which is substituted for every tonne of co-product[4]. Step 4: Give the biofuel a credit which is equal to the amount of co-product produced (per tonne of biofuel), multiplied by the amount of marginal product which is displaced (per tonne of co-product), multiplied by the carbon intensity of the marginal product (per tonne of marginal product). This credit should be negative (i.e. reduces the carbon intensity of the biofuel) – unless the marginal product has a negative carbon intensity.
Allocation by market value	Step 1: Calculate the market value[5] of the products exported from the conversion plant – per tonne of the main biofuel product. Step 2: Calculate the total market value of all products exported from the plant (including the biofuel and the co-products). Step 3: Divide the value per tonne of the main biofuel product by the total value of all exported products (from Step 2) – this is the allocation factor, the proportion of emissions which should be allocated to the biofuel. Step 4 Multiple the emissions which occurred in this module and all upstream emissions by this allocation factor.

2 It is easiest to do this on the basis of the quantity of co-product produced for every tonne of biofuel produced.

3 This analysis will need to be verifiable and should be based on public, peer reviewed studies or, for example carried out to a certain standard – e.g. ISO 14040.

4 In the case where products are not direct substitutes. For example, animal protein feeds might have different protein contents, in which case 1 tonne of the co-product might only substitute 0.8 tonnes of the marginal product.

5 Where possible "market value" should be based on a three year average market price for the product – this can be recalculated annually at the beginning of the RTFO year.

Example of allocation by energy content

An ethanol plant is selling DDGS to an electricity generator for co-firing.

Step 1: Energy content of exported products
Biofuel: 1 tonne of ethanol = 26,800 MJ
Co-product: 1.1 tonne DDGS/tonne ethanol = 17,600 MJ/t ethanol

Step 2: Total energy exported from plant
Total energy = 26,800 + 17,600 = 44,400 MJ/t ethanol

Step 3: Divide energy exported in biofuel by total energy
Allocation factor = 26,800/44,400 = 60 %

Step 4: Multiply upstream emissions and this module's emissions by the allocation factor
Upstream emissions (i.e. production of wheat) = 1,100 kg CO_2e/t ethanol
Conversion plant emissions = 800 kg CO_2e/t ethanol
Carbon intensity of ethanol = (1,100 + 800) x 0.6 = 1,140 kg CO_2e/t ethanol

Make adjustments to the structure of existing fuel chains

12. This section describes how the structure of the default fuel chains given below can be changed. Examples of situations in which companies may wish to do this include:

- If a certain transport step does not occur because, for example the oilseed crushing plant and the biodiesel conversion plant are co-located.
- If feedstock drying occurs within the biofuel plant – removing the drying and storage module would mean that energy consumption for drying and storage could be reported within the biofuel conversion module.
- If oilseed crushing and biodiesel conversion take place within the same plant – using one conversion module means energy consumption could be reported for the plant as a whole and would not have to be allocated between crushing and conversion operations.

13. Companies will be required to maintain evidence that the biofuel was produced in the way represented by the revised fuel chain, for example, that a certain transport step does not occur or that crushing and esterification take place on the same site. If modules are removed from the default fuel chain, companies will be required to use actual data for data points down stream of this module which may have been affected by the changes made – verifiers will review the entire fuel chain and the data used to ensure there are no inconsistencies. For example, within a biodiesel chain, it would not be possible to claim that oilseed crushing and biodiesel conversion take place within one plant, remove the oilseed crushing conversion module and then rely on default values for the biodiesel conversion module. Any changes to a default fuel chain must be recorded transparently – ideally in a format as close as possible to the existing default fuel chains (either electronic or paper-based). Verifiers may request access to this information.

Removing modules

Step 1: Select the appropriate **default fuel chain** to be edited based on the biofuel's feedstock type and origin.

Step 2: Remove the module(s) that is not required.

Step 3: Adjust the structure of the remaining modules to ensure that the new fuel chain is accurate and complete. Changes may need to be made to:

- Units of inputs (e.g. for yields and emission totals)
- The types of co-product being exported.

Step 4: Actual data must be used in place of single default values for any inputs which might have changed as a result of removing a module.

Step 5: Complete all necessary calculations in modules which have been changed – and record changes in the "Fuel Chain Summary" table.

Step 6: If any "yields" have been changed then the "contribution to overall fuel chain" of all upstream modules will need to be recalculated and recorded in the "Fuel Chain Summary" table.

Step 7: The new **fuel chain carbon intensity** can be calculated by summing all the rows given in the "Fuel Chain Summary" table for the specified country of origin (excluding the module which has been removed)

Step 8: For reporting to the RTFO Administrator, this value must be converted to carbon intensity per MJ – using the standard energy content values (lower heating values specified in the General Default Values Section).

Adding modules

14. With the exception of crop production, the modules listed in Figure 2 above can be added to an existing default fuel chain. Table 1 provides a list of the most important sources of GHG emissions which need to be considered within each module. This list is not exhaustive and it is the reporting company's responsibility to ensure that all sources of GHG emission which will influence the final carbon intensity of the biofuel by 1 percent or more are taken into account.

Table 1 Most important sources of GHG emissions

Module	Major sources of GHG emissions
Drying and storage	Fuel (e.g. diesel, fuel oil, natural gas, coal) Electricity

Conversion	Yields[6] Fuel (e.g. natural gas, fuel oil, coal) Electricity Chemicals Co-products
Feedstock transport	Diesel or other fuel for transport
Liquid fuel transport & storage	Diesel or other fuel
Gaseous fuel transport & storage	Gas or other fuel

Every module must include two "totals": the module total (kg CO_2e/t product[7]) and the fuel chain contribution total (kg CO_2e/t biofuel).

Step 1: Select the appropriate **default fuel chain** to be edited based on the biofuel's feedstock type and origin.

Step 2: Add the new module(s) which is required.

Step 3: Adjust the structure of the remaining modules to ensure that the new fuel chain is accurate and complete. Changes may need to be made to:

- Units of inputs (e.g. for yields and emission totals)
- The types of co-product being exported.

Step 4: Actual data will need to be used for all inputs required within the new module – emission factors may be taken from the General Default Values section. In addition, actual data will be required in place of single default values for any inputs which might have changed as a result of adding the new module.

Step 5: Complete all necessary calculations in the modules which have been changed – and record changes in the "Fuel Chain Summary" table (remembering to add the new module as a new row in the table).

Step 6: If the new module has a "yield" associated with it and/or if other modules have had their "yields" altered then the "contribution to overall fuel chain" of all upstream modules will need to be recalculated and recorded in the "Fuel Chain Summary" table.

6 While yields (i.e. tonne output / tonne input) are not a "source" of GHG emissions, they are required to enable the fuel chain contribution total to be calculated within existing modules that are upstream of the added module.

7 Product at this point in the chain.

Step 6: The new **fuel chain carbon intensity** can be calculated by summing all the rows given in the "Fuel Chain Summary" table for the specified country of origin – including the value for the new module which has been added.

Step 7: For reporting to the RTFO Administrator, this value must be converted to carbon intensity per MJ – using the standard energy content values (lower heating values specified in the General Default Values section).

Building a new fuel chain

15. An entirely new fuel chain can be constructed; however, it will almost always be easier to edit an existing default fuel chain. Note that, if a new fuel or feedstock is being introduced to the UK market and none of the existing default fuel chains represent the production processes, it will be necessary to follow the procedures outlined in the main Technical Guidance.

Step 1: Define the steps which occur during the production of a biofuel using the modules shown in Figure 2.

Step 2: Identify the main product which is exported from each module (e.g. wheat, ethanol etc). All emissions within a module must be calculated per tonne of this product.

Step 3: Within each module identify all sources of GHG emissions which will influence the final carbon intensity of the biofuel by 1 percent or more.

Step 4: Within each conversion module identify the co-products which will be produced and decide on the most appropriate treatment based on the rules outlined below.

Step 5: Ensure that each conversion module contains the yield data which is needed to establish the contribution that upstream emissions make to the final carbon intensity of a biofuel.

Step 6: Complete a fuel chain structure in the same format which has been used for the default fuel chains below – verifiers may review this template.

Step 7: Complete the fuel chain structure using actual data and emission factors from the General Default Values section.

Step 8: The new **fuel chain carbon intensity** can be calculated by adding up the contribution of all the different modules.

Step 9: For reporting to the RTFO Administrator, this value must be converted to carbon intensity per MJ – using the standard energy content values (lower heating values specified in the General Default Values section).

Compulsory linkages

16. There are several input fields within a carbon intensity calculation which are inter-dependent – for example, the yield of many crops is influenced heavily by the amount of nitrogen which has been applied. To avoid the possibility of default values being used in an inappropriate fashion a number of "compulsory linkages" have been defined – these are listed in Table 2.

17. If actual data is used for either of the two listed in Table 2, actual data must also be used for the other input. Note it is possible to have actual data which shows the second input is equal to the default value; however, the reporting company must have evidence to support this claim.

Table 2 – Compulsory linkages for all fuel chains, by module.

Input one	Input two
Crop production	
Crop yield	Nitrogen fertiliser application rate
Drying and storage	
Moisture removed	Fuel for heating or electricity
Feedstock transport	
None	
Conversion	
Yield	Any co-product yield
Yield	Steam or electricity demand
Electricity exported	Fuel use
Liquid fuel transport	
None	

General Default values

General default values

Table 3 – Fertiliser and pesticide emissions factors.

	Emissions factor
	[kgCO_2e/kg nutrient]
Nitrogen fertiliser	
Ammonium nitrate*	6.8

Sulphate of ammonia*	1.6
Urea*	2.9
Phosphate fertiliser	
Triple super-phosphate	1.6
Rock phosphate	0.4
MAP (Mono ammonium phosphate)	2.7
Other fertilisers	
K fertiliser	0.8
CaO fertiliser	0.6
MgO fertiliser (kieserite)	1.7
NPK fertiliser (N from Urea)	0.3
	[kg CO_2e /kg pesticide]
Pesticides	17.3

Table 4 – Fossil fuel emission factors.

	Emissions factor
	[kgCO_2e/MJ fuel]
Gasoline	0.085
Diesel	0.086
LPG	0.069
Heavy fuel oil	0.087
Coal	0.112
Natural gas	0.062

Table 5 – Transport mode fuel efficiency

	Emissions factor
	[MJ/tonne-km]
Pipeline	…
Truck – OECD North America	1.46
Truck – OECD Europe	1.53
Truck – OECD Pacific	1.61

	Emissions factor [MJ/tonne-km]
Truck – FSU	1.82
Truck – Eastern Europe	1.72
Truck – China	1.89
Truck – Other Asia	1.8
Truck – India	1.94
Truck – Middle East	1.89
Truck – Latin America	1.8
Truck – Africa	1.94
Rail – OECD North America	0.19
Rail – OECD Europe	0.38
Rail – OECD Pacific	0.38
Rail – FSU	0.19
Rail – Eastern Europe	0.24
Rail – China	0.33
Rail – Other Asia	0.24
Rail – India	0.19
Rail – Middle East	0.24
Rail – Latin America	0.24
Rail – Africa	0.24
Canal barge	…
Coastal shipping	…
International shipping	0.2

Table 6 – Emissions factor for electricity

Country/Region	**kg CO_2/MJ**
Africa	0.179
Argentina	0.076
Australia	0.241
Brazil	0.022
China (including Hong Kong)	0.214
European Union – 27	0.107

Country/Region	kg CO_2/MJ
France	0.023
Germany	0.139
Indonesia	0.216
Malaysia	0.137
Poland	0.184
United Kingdom	0.131
United States	0.160

Table 7 – General information about fuels

Fuel	Density	Lower heating value	
	kg/litre	MJ/kg	MJ/litre
Gasoline	0.745	43.2	32.2
Diesel	0.832	43.1	35.9
HFO	0.970	40.5	39.3
Biodiesel	0.890	37.2	33.1
Ethanol	0.794	26.8	21.3
ETBE	0.750	36.3	27.2
MTBE	0.745	35.1	35.1
Biomethane	--	45.1	--

Selected default values

18. The following tables contain values for selected defaults. For selected defaults on transport mode fuel efficiency see Table 5.

Table 8 – Fertiliser emission factors

	Emissions factor
	[kgCO_2e/kg nutrient]
Nitrogen fertiliser	
AN (Ammonium nitrate)	6.8
SOA (Sulphate of ammonia)	1.6
Urea	2.9

Phosphate fertiliser	
TSP (Triple super-phosphate)	1.6
Rock (Rock phosphate)	0.4
MAP (Mono ammonium phosphate)	2.7

Table 9 – Fossil fuel emission factors

	Emissions factor
	[kgCO_2e/MJ fuel]
Diesel	0.086
Heavy fuel oil	0.087
Coal	0.112
Natural gas	0.062

Table 10 – Energy configuration

	Overall Efficiency	Heat to power ratio
	[%]	[dimensionless]
Simple boiler	90	0
CHP unit	80	3.7

Wheat to ethanol

Fuel chain summary

	Carbon intensity [kg CO_2/t ethanol]			
Module	**Canada**	**France**	**Germany**	**United Kingdom**
1 – Crop production	1686	1527	1333	1376
2 – Drying and storage	88	85	93	92
3 – Feedstock transport	169	34	34	68
4 – Feedstock transport	296	27	38	0
5 – Conversion	559	559	559	559
6 – Liquid fuel transport and storage	0	0	0	0
TOTAL	2797	2232	2057	2096

Selected default options

Stage	Module	Input	Options
1	Crop production	Nitrogen fertiliser emissions factor	Ammonium nitrate, Sulphate of ammonia, Urea
1	Crop production	Phosphorus fertiliser emissions factor	Triple super-phosphate, Rock phosphate
2	Drying and storage	Fuel emissions factor	Diesel, Heavy fuel oil, Coal, Natural gas
3	Feedstock transport (Mode 1)	Transport mode fuel efficiency	Truck (by geographic region), Rail (by geographic region), Shipping
4	Feedstock transport (Mode 2)	Transport mode fuel efficiency	Truck (by geographic region), Rail (by geographic region), Shipping

Stage	Module	Input	Options
5	Conversion	Fuel emissions factor	Coal, Natural gas, Heavy fuel oil, Biomass
5	Conversion	Energy configuration	Simple boiler, CHP unit
6	Liquid fuel transport	Transport mode fuel efficiency	Pipeline, Truck (by geographic region), Rail (by geographic region), Shipping

Default fuel chain

Stage 1 - Crop Production

Description	Cultivation and harvest of wheat							
Basic Data								
Yield @ traded moisture content	Units [t/ha.a]	*value*	Y					
Traded moisture content	%	*value*	M1					
Soil Emissions								
					Emissions co-efficient [$kgCO_2e/ha$]		Emissions [$kgCO_2e$ / twheat]	
N_2O emissions					*calculation* *N FERT x 6.613*	÷ Y =	*calculation*	1
Farming Inputs								
		Mass of input			Emissions co-efficient [$kgCO_2e$/k g nutrient]		Emissions [$kgCO_2e$ / twheat]	
N fertiliser	[kg N / ha.a]	*value* (N FERT)		x	*value*	÷ Y =	*calculation*	2
P fertiliser	[kg P_2O_5 / ha.a]	*value*		x	*value*	÷ Y =	*calculation*	3
K fertiliser	[kg K_2O / ha.a]	*value*		x	*value*	÷ Y =	*calculation*	4
Lime (CaCO3)	[kg $CaCO_3$ / ha.a]	*value*		x	*value*	÷ Y =	*calculation*	5
					Emissions co-efficient [$kgCO_2e$/k g]			
Pesticides	[kg/ha.a]	*value*		x	*value*	÷ Y =	*calculation*	6
Machinery Inputs								
					Emissions co-efficient [$kgCO_2e$/litre]		Emissions [$kgCO_2e$ / twheat]	
Diesel fuel consumption	[litres/ha.a]	*value*		x	*value*	÷ Y =	*calculation*	7
Co-products					Credit [$kgCO_2e/t$]			
Co-product 1	[t co-product 1 / ha.a]	*value*		x	*value*	÷ Y =	*calculation*	8
Totals							Emissions [$kgCO_2e$ / twheat]	
Module total						1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 =	*calculation*	9
							Emissions [kg CO_2e / t ethanol]	
Contribution to fuel chain						(9 ÷ Z) x Allocation =	*calculation*	Stage_1

Stage 2 - Drying and storage

Description	Drying of wheat							
Moisture removed	% by weight	*value*	M2					
Fuel / input type					Emissions co-efficient [kgCO_2e/MJ]		Emissions [kgCO2e / twheat]	
Fuel for heating	[MJ/t wheat]	*value*		x	*value*	=	*calculation*	10
Electricity	[MJ/t wheat]	*value*		x	*value*	=	*calculation*	11
Totals							Emissions [kgCO_2e / twheat]	
Module total						10 + 11 =	*calculation*	12
							Emissions [kg CO_2e / t ethanol]	
Contribution to fuel chain						(12 ÷ Z) x Allocation =	*calculation*	Stage_2

Stage 3 - Feedstock Transport

Description	Drying facility to ethanol plant (Mode 1)							
Transport distance	[km]	*value*	dist_1					
Fuel consumption	[MJ/t-km]	*value*	FC_1					
Totals					Emissions co-efficient [kgCO_2e/MJ]		Emissions [kgCO_2e / wheat]	
Module total	[MJ/t wheat]	*calculation = dist_1 x FC_1*		x	*value*	=	*calculation*	13
							Emissions [kg CO_2e / t ethanol]	
Contribution to fuel chain						(13 ÷ Z) x Allocation =	*calculation*	Stage_3

Stage 4 - Feedstock Transport

Description	Drying facility to ethanol plant (Mode 2)							
Transport distance	[km]	*value*	dist_2					
Fuel consumption	[MJ/t-km]	*value*	FC_2					
Totals					Emissions co-efficient [kgCO_2e/MJ]		Emissions [kgCO_2e / twheat]	
Module total	[MJ/t wheat]	*calculation = dist_2 x FC_2*		x	*value*	=	*calculation*	14
							Emissions [kg CO_2e / t ethanol]	
Contribution to fuel chain						(14 ÷ Z) x Allocation =	*calculation*	Stage_4

Stage 5 - Conversion

Description	Ethanol plant							
Basic data								
Plant yield	[t ethanol / t wheat]	*value*	Z					
Conversion Inputs					Emissions factor ($kgCO_2e/MJ$)		Emissions ($kgCO_2e/t$ ethanol)	
Natural gas	[MJ/t ethanol]	*value*		x	*value*	=	*calculation*	15
Electricity import	[MJ/t ethanol]	*value*		x	*value*	=	*calculation*	16
Co-products								
Co-products treated by substitution					Credit [kg CO_2e/t co- product]			
Quantity of co-product 1	[t co-product 1 / t ethanol]	*value*		x	*value*	=	*calculation*	17
Quantity of co-product 2	[t co-product 2 / t ethanol]	*value*		x	*value*	=	*calculation*	18
Quantity of co-product 3	[t co-product 3 / t ethanol]	*value*		x	*value*	=	*calculation*	19
etc								
Co-products treated by allocation by market value								

Stage 6 - Liquid fuel transport and storage

Description	Ethanol plant to refinery/blending facility							
Transport distance	[km]	*value*	dist_3					
Fuel consumption	[MJ/t-km]	*value*	FC_3					
Totals					Emissions co-efficient [$kgCO_2e/ha$]		Emissions [$kgCO_2$ e / tethanol]	
Module total	[MJ/t ethanol]	*calculation = dist 3 x FC 3*		x	*value*	=	*calculation*	23
Contribution to fuel chain						23 =	*calculation*	Stage_6

Default value tables

Stage/Input	Units	Feedstock country of origin			
		Canada	France	Germany	United Kingdom
Stage 1 – Crop Production					
Yield @ traded moisture content	[t/ha.a]	2.3	7.0	7.4	8.0
Traded moisture content	%	15	15	15	15
N2O emissions from soils	[kgCO_2e/ha.a]	1128	1128	1128	1128
N fertiliser	[kg N/ha.a]	50	183	165	183
Type of N fertiliser		AN	AN	AN	AN
P fertiliser	[kg P_2O_5/ha.a]	26	40	30	40
Type of P fertiliser		TSP	TSP	TSP	TSP
K fertiliser	[kg K_2O/ha.a]	6	45	40	45
Lime	[kg $CaCO_3$/ ha.a]	363	363	363	363
Pesticides	[kg/ha.a]	0.38	0.38	0.38	0.38
Diesel fuel consumption	[litres/ha.a]	70	141	141	141
Straw removed	[t/ha.a]	0	0	0	0
Stage 2 – Drying and storage					
Moisture removed	% by weight	1	1	1	1
Fuel for heating	[MJ/t wheat]	280	280	280	280
Electricity	[MJ/t wheat]	19	19	19	19
Stage 3 – Feedstock Transport					
Transport distance	[km]	3000	300	300	150
Fuel consumption	[MJ/t-km]	0.19	0.38	0.38	1.53
Stage 4 – Feedstock Transport					
Transport distance	[km]	5000	450	650	0
Fuel consumption	[MJ/t-km]	0.2	0.2	0.2	0
Stage 5 – Conversion					

Stage/Input	**Units**	**Feedstock country of origin**			
		Canada	**France**	**Germany**	**United Kingdom**
Yield	[t ethanol/t wheat]	0.292	0.292	0.292	0.292
Natural gas	[MJ/t pure ethanol]	10838	10838	10838	10838
Electricity import	[MJ/t pure ethanol]	1451	1451	1451	1451
Co-products					
Co-product 1:	DDGS sold as animal feed	Substitutes for US soymeal (converted to beans in EU)			
Quantity of DDGS produced & sold as animal feed	[t DDGS/t ethanol]	1.14	1.14	1.14	1.14
Credit for co-product 1	[kg CO_2e/t DDGS]	-241	-241	-241	-241
Stage 6 – Liquid fuel transport and storage					
Transport distance	[km]	0	0	0	0
Fuel consumption	[MJ/t-km]	0	0	0	0

Sugar beet to ethanol

Fuel chain summary

	Carbon intensity [kg CO_2/t ethanol]
Module	United Kingdom
1 – Crop production	588
2 – Feedstock transport	176
3 – Conversion	613
4 – Liquid fuel transport	0
TOTAL	1377

Selected default options

Stage	Module	Input	Options
1	Crop production	Nitrogen fertiliser emissions factor	Ammonium nitrate, Sulphate of ammonia, Urea
1	Crop production	Phosphorus fertiliser emissions factor	Triple super-phosphate, Rock phosphate
2	Feedstock transport	Transport mode fuel efficiency	Truck (by geographic region), Rail (by geographic region), Shipping
3	Conversion	Fuel emissions factor	Coal, Natural gas, Heavy fuel oil, Biomass
3	Conversion	Energy configuration	Simple boiler, CHP unit
4	Liquid fuel transport	Transport mode fuel efficiency	Pipeline, Truck (by geographic region), Rail (by geographic region), Shipping

Default fuel chain

Stage 1 - Crop Production

Description	Cultivation and harvest of sugar beet						
Basic Data							
Yield	Units [t/ha.a]	*value*	Y				
Soil Emissions							
				Emissions factor ($kgCO_2e/ha$)		Emissions ($kgCO_2e/t$ sugar beet)	
N_2O emissions				*calculation N FERT x 6.613*	÷ Y =	*calculation*	1
Farming Inputs							
		Mass of input		Emissions co-efficient [$kgCO_2e/k$ g nutrient]		Emissions ($kgCO_2e/t$ sugar beet)	
N fertiliser	[kg N / ha.a]	*value (N FERT)*	x	*value*	÷ Y =	*calculation*	2
P fertiliser	[kg P_2O_5 / ha.a]	*value*	x	*value*	÷ Y =	*calculation*	3
K fertiliser	[kg K_2O / ha.a]	*value*	x	*value*	÷ Y =	*calculation*	4
Na Fertiliser	[kg Na / ha.a]	*value*	x	*value*	÷ Y =	*calculation*	5
Lime (CaCO3)	[kg $CaCO_3$ / ha.a]	*value*	x	*value*	÷ Y =	*calculation*	6
				Emissions co-efficient [$kgCO_2e/k$ g]			
Pesticides	[kg/ha.a]	*value*	x	*value*	÷ Y =	*calculation*	7
Machinery Inputs							
Diesel fuel consumption	[litres/ha.a]	*value*	x	*value*	÷ Y =	*calculation*	8
On-farm transport to storage clamp	[litres/tonne beet]	*value*	x	*value*	=	*calculation*	9
On-farm cleaning and loading	[litres/tonne beet]	*value*	x	*value*	=	*calculation*	10
Totals						Emissions ($kgCO_2e/t$ sugar beet)	
Module total					1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 + 10 =	*calculation*	11
						Emissions [kg CO_2e / t ethanol]	
Contribution to fuel chain					11 ÷ Z x Allocation =	*calculation*	Stage_1

Stage 2 - Feedstock Transport

Description	Farm to crushing facility						
				Emissions factor ($kgCO_2e/MJ$)			
Transport distance	[km]	*value*	dist_1				
Fuel consumption	[MJ/t-km]	*value*	FC_1				
Totals						Emissions ($kgCO_2e/t$ sugar beet)	
Module total	[MJ/t]	*calculation = dist 1 x FC 1*	x	*value*	=	*calculation*	12
						Emissions [kg CO_2e / t ethanol]	
Contribution to fuel chain					12 ÷ Z x Allocation =	*calculation*	Stage_2

Stage 3 - Conversion

Description	Ethanol plant							
Basic data								
Plant yield	[t ethanol / t sugar beet]	*value*	Z					
Conversion Inputs					Emissions factor ($kgCO_2e/MJ$)		Emissions ($kgCO_2e/t$ ethanol)	
Natural gas	[MJ/t pure ethanol]	*value*		x	*value*	=	*calculation*	13
Electricity import	[MJ/t pure ethanol]	*value*		x	*value*	=	*calculation*	14
Co-products								
Co-products treated by substitution					Credit [kg CO_2e/t co- product]			
Quantity of co-product 1	[t co-product 1 / t ethanol]	*value*		x	*value*	=	*calculation*	15
Quantity of co-product 2	[t co-product 2 / t ethanol]	*value*		x	*value*	=	*calculation*	16
Quantity of co-product 3	[t co-product 3 / t ethanol]	*value*		x	*value*	=	*calculation*	17
etc								
Co-products treated by allocation by market value								
Allocation factor - percentage of emissions attributable to ethanol	%						*calculation*	Allocation
Co-products treated by allocation by energy content								
Allocation factor - percentage of emissions attributable to ethanol	%						*calculation*	Allocation
Totals							Emissions [kg CO_2 e / t ethanol]	
Module total					(13 + 14 + 15 + 16 + 17) x Allocation =		*calculation*	18
Contribution to fuel chain						18 =	*calculation*	Stage_3

Stage 4 - Liquid fuel transport and storage

Description	From ethanol plant to refinery/blending facility							
Transport distance	[km]	*value*	dist_2					
Fuel consumption	[MJ/t-km]	*value*	FC_2					
					Emissions factor ($kgCO_2e/MJ$)		Emissions [kg CO_2e / t ethanol]	
Module total	[MJ/t ethanol]	*calculation* *= dist 2 x FC 2*		x	*value*	=	*calculation*	19
Contribution to fuel chain						19 =	*calculation*	Stage_4

Default value tables

Stage/Input	**Units**	**Value**
Stage 1 – Crop Production		
Yield	[t/ha.a]	58
N2O emissions from soils	[kgCO_2e/ha.a]	616
N fertiliser	[kg N/ha.a]	100
Type of N fertiliser		AN
P fertiliser	[kg P_2O_5/ha.a]	50
Type of P fertiliser		TSP
K fertiliser	[kg/ha.a]	120
Na Fertiliser	[kg/ha.a]	100
Lime	[kg/ha.a]	300
Pesticides	[kg/ha.a]	0.3
Diesel fuel consumption	[litres/ha.a]	168
On-farm transport to storage clamp	[litres/tonne beet]	0.8
On-farm cleaning and loading	[litres/tonne beet]	0.5
Stage 2 – Feedstock Transport		
Transport distance	[km]	100
Fuel consumption	[MJ/t-km]	1.53
Stage 3 – Conversion		
Yield	[t ethanol/t sugar beet]	0.08
Natural gas	[MJ/t pure ethanol]	13333
Electricity import	[MJ/t pure ethanol]	1800
Co-products:		
Co-product 1:	Pulp sold as animal feed	Substitutes for UK wheat
Quantity of pulp produced & sold as animal feed	[t pulp/t ethanol]	1.251
Credit for co-product 1	[kgCO_2e/t pulp]	-337
Co-production 2:	Lime	Substitutes for agricultural lime
Quantity of lime produced & sold as fertiliser	[t lime/t ethanol]	0.566

Stage/Input	Units	Value
Credit for co-product 2	[kgCO_2e/t lime]	-49
Stage 4 – Liquid fuel transport and storage		
Transport distance	[km]	0
Fuel consumption	[MJ/t-km]	0

Sugar cane to ethanol

Fuel chain summary

	Carbon intensity [kg CO_2/t ethanol]
Module	Brazil
1 – Crop production	229
2 – Feedstock transport	49
3 – Conversion	0
4 – Liquid fuel transport	94
5 – Liquid fuel transport	175
TOTAL	547

Selected default options

Stage	Module	Input	Options
1	Crop production	Nitrogen fertiliser emissions factor	Ammonium nitrate, Sulphate of ammonia, Urea
1	Crop production	Phosphorus fertiliser emissions factor	Triple super-phosphate, Rock phosphate
2	Feedstock transport	Transport mode fuel efficiency	Truck (by geographic region), Rail (by geographic region), Shipping
4	Liquid fuel transport	Transport mode fuel efficiency	Pipeline, Truck (by geographic region), Rail (by geographic region), Shipping
5	Liquid fuel transport	Transport mode fuel efficiency	Pipeline, Truck (by geographic region), Rail (by geographic region), Shipping

Default fuel chain

Stage 1 - Crop Production

Description	Sugar cane cultivation and harvesting							
Basic Data								
Yield	Units [t/ha.a]	*value*	Y					
Sucrose % cane	[%]	*value*	S					
Trash yield (% cane)	[%]	*value*	St					
Sugar cane burning area	[%]	*value*	Bc					
Mechanical Harvesting Area	[%]	*value*	Mc					
Soil Emissions					Emissions factor ($kgCO_2e/ha$)		Emissions ($kgCO_2e/t$ cane)	
N_2O emissions					*calculation N FERT x 6.613*	÷ Y =	*calculation*	1
		Mass of input			Emissions co-efficient [$kgCO_2e/k$ g nutrient]		Emissions ($kgCO_2e/t$ cane)	
N fertiliser	[kg N / ha.a]	*value (N FERT)*		x	*value*	÷ Y =	*calculation*	2
P fertiliser	[kg P_2O_5 / ha.a]	*value*		x	*value*	÷ Y =	*calculation*	3
K fertiliser	[kg K_2O / ha.a]	*value*		x	*value*	÷ Y =	*calculation*	4
Lime (CaCO3)	[kg $CaCO_3$ / ha.a]	*value*		x	*value*	÷ Y =	*calculation*	5
					Emissions co-efficient [$kgCO_2e/k$ g]			
Pesticides	[kg/ha.a]	*value*		x	*value*	÷ Y =	*calculation*	6
Diesel use in agricultural operations								
Diesel: Soil preparation and planting	[litres/ha.a]	*value*		x	*value*	÷ Y =	*calculation*	7
Diesel: Ratoon cultivation	[litres/ha.a]	*value*		x	*value*	÷ Y =	*calculation*	8
Diesel: Mechanical harvesting	[litres/ha.a]	*value*		x	*value*	x (Mc ÷ Y) =	*calculation*	9
Diesel: Manual Harvesting	[litres/ha.a]	*value*		x	*value*	x ((1-Mc) ÷ Y) =	*calculation*	10
Emissions from burning sugar cane trash					Emissions Factor kg CO_2 e qv / kg trash			
N_2O	[kg trash / t cane]	*value*		x	*value*	x Bc =	*calculation*	11
Methane	[kg trash / t cane]	*value*		x	*value*	x Bc =	*calculation*	12
Totals							Emissions ($kgCO_2e/t$ cane)	
Module total						1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 + 10 + 11 + 12 =	*calculation*	13
							Emissions [kg CO_2e / t ethanol]	
Contribution to fuel chain						(13 ÷ Z2) x Allocation =	*calculation*	Stage_1

Stage 2 - Feedstock Transport

Description	From farm to ethanol plant							
Average transport distance	[km]	*value*	dist_1					
Fuel consumption	[MJ/t.km]	*value*	FC_1					
Totals					Emissions factor ($kgCO_2e/MJ$)		Emissions ($kgCO_2e/t$ cane)	
Module total	[MJ/t cane]	*calculation = dist 1 x FC 1*		x	*value*	=	*calculation*	14
							Emissions [kg CO_2e / t ethanol]	
Contribution to fuel chain						(14 ÷ Z2) x Allocation =	*calculation*	Stage_2

Stage 3 - Conversion

Description	Ethanol plant							
Basic Data								
Plant yield	[m3 ethanol / t cane]	*value*	Z1					
Plant yield	[t ethanol / t cane]	*calculation = Z1 x 0.794*	Z2					
Co-products								
Co-products treated by substitution					Credit [kg CO_2e/t co- product]			
Quantity of co-product 1	[t co-product 1 / t ethanol]	*value*		x	*value*	=	*calculation*	15
Quantity of co-product 2	[t co-product 2 / t ethanol]	*value*		x	*value*	=	*calculation*	16
Quantity of co-product 3	[t co-product 3 / t ethanol]	*value*		x	*value*	=	*calculation*	17
etc								
Co-products treated by allocation by market value								
Allocation factor - percentage of emissions attributable to ethanol	%						*calculation*	Allocation
Co-products treated by allocation by energy content								
Allocation factor - percentage of emissions attributable to ethanol	%						*calculation*	Allocation
Totals							Emissions [kg CO_2e / t ethanol]	
Module total						(15 + 16 + 17) x Allocation =	*value*	18
Contribution to fuel chain						18 =	*value*	Stage_3

Stage 4 - Liquid fuel transport and storage

Description	From ethanol plant to refinery/blending facility							
Transport distance	[km]	*value*	dist					
Fuel consumption	[MJ/t-km]	*value*	FC					
					Emissions factor ($kgCO_2e/MJ$)		Emissions [kg CO_2e / t ethanol]	
Module total	[MJ/t ethanol]	*value*		x	*value*	=	*calculation*	19
Contribution to fuel chain						19 =	*calculation*	Stage_4

Stage 5 - Liquid fuel transport and storage

Description	From ethanol plant to refinery/blending facility							
Transport distance	[km]	*value*	dist_2					
Fuel consumption	[MJ/t-km]	*value*	FC_2					
					Emissions factor ($kgCO_2e/MJ$)		Emissions [kg CO_2e / t ethanol]	
Module total	[MJ/ethanol]	*calculation = dist 2 x FC 2*		x	*value*	=	*calculation*	20
Contribution to fuel chain						20 =	*calculation*	Stage_5

Default value tables

Stage/Input	Units	Value
Stage 1 – Crop Production		
Yield	[t/ha.a]	68.7
Sucrose % cane	[%]	14.2
Trash yield (% cane)	[%]	14
Sugar cane burning area	[%]	77
Mechanical Harvesting Area	[%]	34
N2O emissions from soils	[kg CO_2e/ha.a]	382.1
N fertiliser	[kg N/ha.a]	62
Type of N fertiliser		Urea
P fertiliser	[kg P_2O_5/ha.a]	31
Type of P fertiliser		MAP
K fertiliser	[kg/ha.a]	67
Lime	[kg/ha.a]	60
Pesticides	[kg/ha.a]	0.2
Diesel: Soil preparation and planting	[litres/ha.a]	17.4
Diesel: Ratoon cultivation	[litres/ha.a]	6.1
Diesel: Mechanical harvesting	[litres/ha.a]	78.9
Diesel: Manual Harvesting	[litres/ha.a]	22.2
N_2O from burning trash	[kg trash/t cane]	14
Methane from burning trash	[kg trash/t cane]	14
Stage 2 – Feedstock Transport		
Average transport distance	[km]	20
Fuel consumption	[MJ/t.km]	1.8
Stage 3 – Conversion		
Yield	[m3 ethanol/t cane]	0.08
No co-products		
Stage 4 – Liquid fuel transport and storage		
Transport distance	[km]	600
Fuel consumption	[MJ/t-km]	1.8

Stage/Input	Units	Value
Stage 5 – Liquid fuel transport and storage		
Transport distance	[km]	10,000
Fuel consumption	[MJ/t-km]	0.2

Corn to ethanol

Fuel chain summary

	Carbon intensity [kg CO_2/t ethanol]	
Module	USA	France
1 – Crop production	941	1106
2 – Drying and storage	179	55
3 – Feedstock transport	30	30
4 – Conversion	2064	476
5 – Liquid fuel transport and storage	27	8
6 – Liquid fuel transport and storage	122	
TOTAL	3362	1674

Selected default options

Stage	Module	Input	Options
1	Crop production	Nitrogen fertiliser emissions factor	Ammonium nitrate, Sulphate of ammonia, Urea
1	Crop production	Phosphorus fertiliser emissions factor	Triple super-phosphate, Rock phosphate
2	Drying and storage	Fuel emissions factor	Diesel, Heavy fuel oil, Coal, Natural gas
3	Feedstock transport	Transport mode fuel efficiency	Truck (by geographic region), Rail (by geographic region), Shipping
4	Conversion	Fuel emissions factor	Coal, Natural gas, Heavy fuel oil, Biomass
4	Conversion	Energy configuration	Simple boiler, CHP unit
5	Liquid fuel transport	Transport mode fuel efficiency	Pipeline, Truck (by geographic region), Rail (by geographic region), Shipping

Default fuel chain

Stage 1 - Crop Production

Description	Cultivation and harvest of corn							
Basic Data								
Yield @ traded moisture content	Units [t corn / ha.a]	*value*	Y					
Traded moisture content	%	*value*	M1					
Soil Emissions								
					Emissions factor ($kgCO_2e$/ha)		Emissions ($kgCO_2e$/t corn)	
N_2O emissions					*calculation* *N FERT x 6.613*	÷ Y =	*calculation*	1
Farming Inputs								
		Mass of input			Emissions co-efficient [$kgCO_2e$/k g nutrient]		Emissions ($kgCO_2e$/t corn)	
N fertiliser	[kg N / ha.a]	*value* (N FERT)		x	*value*	÷ Y =	*calculation*	2
P fertiliser	[kg P_2O_5 / ha.a]	*value*		x	*value*	÷ Y =	*calculation*	3
K fertiliser	[kg K_2O / ha.a]	*value*		x	*value*	÷ Y =	*calculation*	4
Lime (CaCO3)	[kg $CaCO_3$ / ha.a]	*value*		x	*value*	÷ Y =	*calculation*	5
					Emissions co-efficient [$kgCO_2e$/k g]			
Pesticides	[kg/ha.a]	*value*		x	*value*	÷ Y =	*calculation*	6
Machinery Inputs								
					Emissions factor ($kgCO_2e$/litre)			
Diesel fuel consumption	[litres/ha.a]	*value*		x	*value*	÷ Y =	*calculation*	7
Coproducts					Emissions co-efficient [$kgCO_2e$/t]			
Credit	[t/ha.a]	*value*		x	*value*	÷ Y =	*calculation*	8
Totals							Emissions ($kgCO_2e$/t corn)	
Module total						1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 =	*calculation*	9
							Emissions [kg CO_2e / t ethanol]	
Contribution to fuel chain						(9) x Allocation =	*calculation*	Stage_1

Stage 2 - Drying and storage

Description	Drying of corn							
Moisture removed	% by weight	*value*	M2					
Fuel / input type					Emissions co-efficient [$kgCO_2e$/MJ]		Emissions [$kgCO_2e$ / tcorn]	
Fuel for heating	[MJ/t corn]	*value*		x	*value*	=	*calculation*	10
Electricity	[MJ/t corn]	*value*		x	*value*	=	*calculation*	11
Totals							Emissions [$kgCO_2e$ / tcorn]	
Module total						10 + 11 =	*calculation*	12
							Emissions [kg CO_2e / t ethanol]	
Contribution to fuel chain						(12) x Allocation =	*calculation*	Stage_2

Stage 3 - Feedstock Transport

Description	Farm to ethanol plant							
					Emissions factor (kgCO2e/MJ)			
Transport distance	[km]	*value*	dist_1					
Fuel consumption	[MJ/t-km]	*value*	FC_1					
Totals							Emissions ($kgCO_2e$/t corn)	
Module total	[MJ/t]	*calculation* *= dist 1 x FC 1*		x	*value*	=	*calculation*	13
							Emissions [kg CO_2e / t ethanol]	
Contribution to fuel chain						(13) x Allocation =	*calculation*	Stage_3

Stage 4 - Conversion

Description	Ethanol plant						
Basic data							
Plant yield	[t ethanol / t corn]	*value*	Z				
Conversion Inputs				Emissions factor ($kgCO_2e/MJ$)		Emissions ($kgCO_2e/t$ ethanol)	
Coal	[MJ/t pure ethanol]	*value*	x	*value*	=	*calculation*	14
Electricity import	[MJ/t pure ethanol]	*value*	x	*value*	=	*calculation*	15
Co-products							
Co-products treated by substitution				Credit [kg CO_2e/t co- product]			
Quantity of co-product 1	[t co-product 1 / t ethanol]	*value*	x	*value*	=	*calculation*	16
Quantity of co-product 2	[t co-product 2 / t ethanol]	*value*	x	*value*	=	*calculation*	17
Quantity of co-product 3	[t co-product 3 / t ethanol]	*value*	x	*value*	=	*calculation*	18
etc							
Co-products treated by allocation by market value							
Allocation factor - percentage of emissions attributable to ethanol	%					*calculation*	Allocation
Co-products treated by allocation by energy content							
Allocation factor - percentage of emissions attributable to ethanol	%					*calculation*	Allocation
Totals						Emissions ($kgCO_2e/t$ ethanol)	
Module total					(14 + 15 + 16 + 17 + 18) x Allocation =	*calculation*	19
						Emissions [kg CO_2e / t ethanol]	
Contribution to fuel chain					19 =	*calculation*	Stage_4

Stage 5 - Liquid fuel transport and storage

Description	Ethanol plant to refinery/blending facility						
Transport distance	[km]	*value*	dist_2				
Fuel consumption	[MJ/t-km]	*value*	FC_2				
Totals				Emissions factor ($kgCO_2e/MJ$)		Emissions ($kgCO_2e/t$ ethanol)	
Module total	[MJ/t ethanol]	*calculation = dist 2 x FC 2*	x	*value*	=	*calculation*	20
Contribution to fuel chain					20 =	*calculation*	Stage_5

Stage 6 - Liquid fuel transport and storage

Description	Ethanol plant to refinery/blending facility						
Transport distance	[km]	*value*	dist_3				
Fuel consumption	[MJ/t-km]	*value*	FC_3				
Totals				Emissions factor (kgCO2e/MJ)		Emissions ($kgCO_2e/t$ ethanol)	
Module total	[MJ/t ethanol]	*calculation = dist 3 x FC 3*	x	*value*	=	*calculation*	21
						Emissions [kg CO_2e / t ethanol]	
Contribution to fuel chain					21 =	*calculation*	Stage_6

Default value tables

Stage/Input	**Units**	**Feedstock country of origin**	
		USA	France
Stage 1 – Crop Production			
Yield @ traded moisture content	[t corn/ha.a]	8.9	8.5
Traded moisture content	%	15	15
N2O emissions from soils	[kgCO_2e/ha.a]	924	1048
N fertiliser	[kg N/ha.a]	150	170
Type of N fertiliser		AN	AN
P fertiliser	[kg P_2O_5/ha.a]	70	39
Type of P fertiliser		TSP	TSP
K fertiliser	[kg/ha.a]	90	56
Lime	[kg/ha.a]	469	469
Pesticides	[kg/ha.a]	4	4
Diesel fuel consumption	[litres/ha.a]	131	131
Straw removed	[t/ha.a]	0	0
Stage 2 – Drying and storage			
Moisture removed	% by weight	3	1
Fuel for heating	[MJ/t corn]	841	280
Electricity	[MJ/t corn]	56	19
Stage 3 – Feedstock Transport			
Transport distance	[km]	80	300
Fuel consumption	[MJ/t-km]	1.46	0.38
Stage 4 – Conversion			
Yield	[t ethanol/t corn]	0.31	0.326
Coal	[MJ/t pure ethanol]	23038	0
Natural gas	[MJ/t pure ethanol]	0	11335
Electricity import	[MJ/t pure ethanol]	0	1260
Co-products			
Co-product 1	Corn oil	Substitutes for US soybean oil (crushed in US)	

Stage/Input	**Units**	**Feedstock country of origin**	
Quantity of corn oil produced	[t corn oil/t ethanol]	0.122	0
Credit for co-product 1	[kgCO_2e/t corn oil]	-810	N/A
Co-product 2	Corn gluten meal	Substitutes for whole corn & nitrogen in urea	
Quantity of corn gluten meal produced	[t corn gluten meal/t ethanol]	0.152	0
Credit for co-product 2	[kgCO_2e/t corn gluten meal]	-124	N/A
Co-product 3	Corn gluten feed	Substitutes for whole corn & nitrogen in urea	
Quantity of corn gluten feed produced	[t corn gluten feed/t ethanol]	0.657	0
Credit for co-product 3	[kgCO_2e/t corn gluten feed]	-283	N/A
Co-product 4	DDGS	Substitutes US soymeal (crushed in EU)	
Quantity of DDGS	[t DDGS/t ethanol]	0	0.96
Credit for co-product 4	[kgCO_2e/t DDGS]	N/A	-241
Co-product 5	Electricity	Allocation by energy content	
Electricity exported	[MJ electricity export/t ethanol]	2661	0
Stage 5 – Liquid fuel transport and storage			
Transport distance	[km]	1600	450
Fuel consumption	[MJ/t-km]	0.19	0.2
Stage 6 – Liquid fuel transport and storage			
Transport distance	[km]	7000	0
Fuel consumption	[MJ/t-km]	0.2	0

Oilseed rape to biodiesel

Fuel chain summary

	Carbon intensity [kg CO_2/t biodiesel]					
Module	Australia	Canada	France	Germany	Poland	United Kingdom
1 – Crop production	2139	2058	1802	1809	1667	2185
2 – Drying and storage	0	311	302	328	339	327
3 – Feedstock transport	24	120	96	96	96	32
4 – Conversion (crushing)	-162	-225	-239	-198	-182	-201
5 – Feedstock transport	400	95	8	12	27	0
6 – Conversion (esterification)	519	519	519	519	519	519
7 – Liquid fuel transport and storage	0	0	0	0	0	0
TOTAL	**2920**	**2877**	**2488**	**2566**	**2465**	**2862**

Selected default options

Stage	**Module**	**Input**	**Options**
1	Crop production	Nitrogen fertiliser emissions factor	Ammonium nitrate, Sulphate of ammonia, Urea
1	Crop production	Phosphorus fertiliser emissions factor	Triple super-phosphate, Rock phosphate
2	Drying and storage	Fuel emissions factor	Diesel, Heavy fuel oil, Coal, Natural gas
3	Feedstock transport	Transport mode fuel efficiency	Truck (by geographic region), Rail (by geographic region), Shipping
4	Conversion (crushing)	Fuel emissions factor	Coal, Natural gas, Heavy fuel oil, Biomass

Stage	Module	Input	Options
4	Conversion (crushing)	Energy configuration	Simple boiler, CHP unit
5	Feedstock transport	Transport mode fuel efficiency	Truck (by geographic region), Rail (by geographic region), Shipping
6	Conversion (esterification)	Fuel emissions factor	Coal, Natural gas, Heavy fuel oil, Biomass
6	Conversion (esterification)	Energy configuration	Simple boiler, CHP unit
7	Liquid fuel transport	Transport mode fuel efficiency	Pipeline, Truck (by geographic region), Rail (by geographic region), Shipping

Default fuel chain

Stage 1 - Crop Production

Description	Cultivation and harvesting of oilseed rape						
Basic Data							
	Units						
Yield @ traded moisture content	[t/ha.a]	*value*	Y				
Traded moisture content	%	*value*	M1				
Soil Emissions							
				Emissions factor ($kgCO_2e/ha$)		Emissions ($kgCO_2e/t$ OSR)	
N_2O emissions				*calculation N FERT x 6.613*	÷ Y =	*calculation*	1
Farming Inputs							
		Mass of input		Emissions co-efficient [$kgCO_2e/kg$ nutrient]		Emissions	
N fertiliser	[kg N / ha.a]	*value* (N FERT)	x	*value*	÷ Y =	*calculation*	2
P fertiliser	[kg P_2O_5 / ha.a]	*value*	x	*value*	÷ Y =	*calculation*	3
K fertiliser	[kg K_2O / ha.a]	*value*	x	*value*	÷ Y =	*calculation*	4
Lime (CaCO3)	[kg $CaCO_3$ / ha.a]	*value*	x	*value*	÷ Y =	*calculation*	5
				Emissions co-efficient [$kgCO_2e/kg$]			
Pesticides	[kg/ha.a]	*value*	x	*value*	÷ Y =	*calculation*	6
Machinery Inputs							
Diesel fuel consumption	[litres/ha.a]	*value*	x	*value*	÷ Y =	*calculation*	7
Totals						Emissions ($kgCO_2e/t$ OSR)	
Module total					1 + 2 + 3 + 4 + 5 + 6 + 7 =	*calculation*	8
						Emissions [$kgCO_2e/t$ biodiesel]	
Contribution to fuel chain					(8) ÷ Z1 ÷ Z2 x Allocation_1 x Allocation_2 =	*calculation*	Stage_1

Stage 2 - Drying and storage

Description	Drying and storage of oilseed rape							
Basic Data								
Moisture removed	% by weight	*value*	M2					
Drying and storage inputs					Emissions factor ($kgCO_2e/MJ$)		Emissions ($kgCO_2e/t$ OSR)	
Fuel for heating	[MJ/t OSR]	*value*		x	*value*	=	*calculation*	9
Electricity	[MJ/t OSR]	*value*		x	*value*	=	*calculation*	10
Totals							Emissions ($kgCO_2e/t$ OSR)	
Module total						9 + 10 =	*calculation*	11
							Emissions [$kgCO_2e/t$ biodiesel]	
Contribution to fuel chain						(11) ÷ Z1 ÷ Z2 x Allocation_1 x Allocation_2 =	*calculation*	Stage_2

Stage 3 - Feedstock Transport

Description	From farm to oilseed crusher							
					Emissions factor ($kgCO_2e/MJ$)			
Transport distance	[km]	*value*	dist_1					
Fuel consumption	[MJ/t-km]	*value*	FC_1					
Totals							Emissions ($kgCO_2e/t$ OSR)	
Module total	[MJ/t OSR]	*calculation = dist_1 x FC_1*		x	*value*	=	*calculation*	12
							Emissions [$kgCO_2e/t$ biodiesel]	
Contribution to fuel chain						(12) ÷ Z1 ÷ Z2 x Allocation_1 x Allocation_2 =	*calculation*	Stage_3

Stage 4 - Conversion

Description	Oil extraction							
Basic Data								
Plant yield	[t rapeseed oil / t oilseed rape]	*value*	Z1					
Conversion Inputs					Emissions factor ($kgCO_2e/MJ$)		Emissions ($kgCO_2e/t$ ethanol)	
Natural gas	[MJ/t rapeseed oil]	*value*		x	*value*	=	*calculation*	13
Electricity imported	[MJ/t rapeseed oil]	*value*		x	*value*	=	*calculation*	14
					Emissions factor ($kgCO_2e/Nm3$)			
Nitrogen	[Nm3/t rapeseed oil]	*value*		x	*value*	=	*calculation*	15
Co-products								
Co-products treated by substitution					Credit [kg CO_2e/t co-product]			
Quantity of co-product 1	[t co-product 1 / t rapeseed oil]	*value*		x	*value*	=	*calculation*	16
Quantity of co-product 2	[t co-product 2 / t rapeseed oil]	*value*		x	*value*	=	*calculation*	17
Quantity of co-product 3	[t co-product 3 / t rapeseed oil]	*value*		x	*value*	=	*calculation*	18
etc								
Co-products treated by allocation by market value								
Allocation factor - percentage of emissions attributable to rapeseed oil	%						*calculation*	Allocation_1
Co-products treated by allocation by energy content								
Allocation factor - percentage of emissions attributable to rapeseed oil	%						*calculation*	Allocation_1
Totals								
Module total						(13 + 14 + 15 + 16 + 17 + 18) x Allocation_1 =	*calculation*	19
							Emissions [$kgCO_2e/t$ biodiesel]	
Contribution to fuel chain						(19) ÷ Z2 x Allocation_2 =	*calculation*	Stage_4

Stage 5 - Feedstock Transport

Description	From extraction facility to biodiesel plant							
					Emissions factor ($kgCO_2e/MJ$)			
Transport distance	[km]	*value*	dist_2					
Fuel consumption	[MJ/t-km]	*value*	FC_2					
Totals							Emissions ($kgCO_2e/t$ rapeseed oil)	
Module total	[MJ / t rapeseed oil]	*calculation = dist 2 x FC 2*		x	*value*	=	*calculation*	20
Contribution to fuel chain						(20) ÷ Z2 x Allocation_2 =	*calculation*	Stage_5

Stage 6 - Conversion

Description	Biodiesel plant							
Basic data								
Plant yield	[t biodiesel / t rapeseed oil]	*value*	Z2					
Conversion Inputs					Emissions factor ($kgCO_2e/MJ$)		Emissions ($kgCO_2e/t$ ethanol)	
Natural gas	[MJ/t biodiesel]	*value*		x	*value*	=	*calculation*	21
Electricity imported	[MJ/t biodiesel]	*value*		x	*value*	=	*calculation*	22
					Emissions factor ($kgCO_2e/k$ g)			
Methanol	kg/t biodiesel	*value*		x	*value*	=	*calculation*	23
Potassium hydroxide	kg/t biodiesel	*value*		x	*value*	=	*calculation*	24
Co-products								
Co-products treated by substitution					Credit [kg CO_2e/t co- product]			
Quantity of co-product 1	[t co-product 1 / t biodiesel]	*value*		x	*value*	=	*calculation*	25
Quantity of co-product 2	[t co-product 2 / t biodiesel]	*value*		x	*value*	=	*calculation*	26
Quantity of co-product 3	[t co-product 3 / t biodiesel]	*value*		x	*value*	=	*calculation*	27
etc								
Co-products treated by allocation by market value								
Allocation factor - percentage of emissions attributable to biodiesel	%						*calculation*	Allocation_2
Co-products treated by allocation by energy content								
Allocation factor - percentage of emissions attributable to biodiesel	%						*calculation*	Allocation_2
Totals							Emissions [$kgCO_2e/t$ biodiesel]	
Module total						(21+ 22 + 23 + 24 + 25 + 26 + 27) x Allocation_2 =	*calculation*	28
Contribution to fuel chain						28 =	*calculation*	Stage_6

Default value tables

Stage/Input	Units	Feedstock country of origin					
		Australia	Canada	France	Germany	Poland	United Kingdom
Stage 1 – Crop production							
Yield @ traded moisture content	[t/ha.a]	1.20	1.46	3.19	3.45	2.38	3.03
Traded moisture content	%	9	9	9	9	9	9
N2O emissions		379	462	955	1048	629	1140
N fertiliser	[kg/ha.a]	61	75	155	170	102	185
P fertiliser	[kg/ha.a]	16	20	45	45	35	45
K fertiliser	[kg/ha.a]	12	15	80	90	44	48
Lime	[kg/ha.a]	18.9	18.9	18.9	18.9	18.9	18.9
Pesticides	[kg/ha.a]	0.28	0.28	0.28	0.28	0.28	0.28
Diesel fuel consumption	[litres/ha.a]	67	67	67	67	67	67
Stage 2 – Drying and storage							
Moisture removed	% by weight	0	5	5	5	5	5
Fuel for heating	[MJ/t OSR]	0	1403	1403	1403	1403	1403
Electricity	[MJ/t OSR]	0	93	93	93	93	93
Stage 3 – Feedstock Transport							
Transport distance	[km]	300	3000	300	300	300	100
Fuel consumption	[MJ/t-km]	0.38	0.19	1.53	1.53	1.53	1.53
Stage 4 – Conversion							
Plant yield	[t rapeseed oil/ t oilseed rape]	0.43	0.43	0.43	0.43	0.43	0.43

Stage/Input	Units	Feedstock country of origin					
		Australia	Canada	France	Germany	Poland	United Kingdom
Natural gas	[MJ/t rapeseed oil]	1985	1985	1985	1985	1985	1985
Electricity imported	[MJ/t rapeseed oil]	337	337	337	337	337	337
Nitrogen	[Nm3/t rapeseed oil]	0.24	0.24	0.24	0.24	0.24	0.24
Co-product 1: Rape meal – sold as animal feed		Substitutes US soy meal (soybeans crushed in EU)					
Quantity of rape meal	[t rape meal/t rapeseed oil]	1.32	1.32	1.32	1.32	1.32	1.32
Credit for co-product 1	[kgCO_2e/t rape meal]	-247	-247	-247	-247	-247	-247
Allocation factor	%	100	100	100	100	100	100
Stage 5 – Feedstock Transport							
Transport distance	[km]	22000	5200	450	650	1500	0
Fuel consumption	[MJ/t-km]	0.2	0.2	0.2	0.2	0.2	0
Stage 6 – Conversion							
Plant yield	[t biodiesel/t rapeseed oil]	0.95	0.95	0.95	0.95	0.95	0.95
Natural gas	[MJ/t biodiesel]	1690	1690	1690	1690	1690	1690
Electricity imported	[MJ/t biodiesel]	335	335	335	335	335	335
Methanol	kg/t biodiesel	113	113	113	113	113	113

Stage/Input	Units	Feedstock country of origin					
		Australia	Canada	France	Germany	Poland	United Kingdom
Potassium hydroxide	kg/t biodiesel	26	26	26	26	26	26
Co-products							
Co-product 1	Crude glycerine	Allocation – by market value					
Quantity of crude glycerine	[t glycerine/t biodiesel]	0.1	0.1	0.1	0.1	0.1	0.1
Market value of glycerine	[£/t glycerine]	0	0	0	0	0	0
Co-product 2:	Potassium sulphate	Allocation – by market value					
Quantity of potassium sulphate	[t potassium sulphate/t biodiesel]	0.04	0.04	0.04	0.04	0.04	0.04
Market value of potassium sulphate	[£/t potassium sulphate]	75	75	75	75	75	75
Primary product: biodiesel							
Market value of biodiesel	[£/t biodiesel]	340	340	340	340	340	340
Allocation factor	%	99	99	99	99	99	99
Stage 7 – Liquid fuel transport and storage							
Transport distance	[km]	0	0	0	0	0	0
Fuel consumption	[MJ/t-km]	0	0	0	0	0	0

Soy to biodiesel

Fuel chain summary

	Carbon intensity [kg CO_2/t biodiesel]		
	Argentina	Brazil	USA
1 – Crop production	878	1287	1817
2 – Drying and storage	262	252	278
3 – Feedstock transport	315	1432	77
4 – Conversion (crushing)	-1385	-1469	-1257
5 – Feedstock transport	0	0	26
6 – Feedstock transport	237	182	127
7 – Conversion (esterification)	519	519	519
8 – Liquid fuel transport	0	0	0
TOTAL	**825**	**2202**	**1182**

Selected default options

Stage	Module	Input	Options
1	Crop production	Nitrogen fertiliser emissions factor	Ammonium nitrate, Sulphate of ammonia, Urea
1	Crop production	Phosphorus fertiliser emissions factor	Triple super-phosphate, Rock phosphate
2	Drying and storage	Fuel emissions factor	Diesel, Heavy fuel oil, Coal, Natural gas
3	Feedstock transport	Transport mode fuel efficiency	Truck (by geographic region), Rail (by geographic region), Shipping
4	Conversion (crushing)	Fuel emissions factor	Coal, Natural gas, Heavy fuel oil, Biomass

Stage	Module	Input	Options
4	Conversion (crushing)	Energy configuration	Simple boiler, CHP unit
5	Feedstock transport	Transport mode fuel efficiency	Truck (by geographic region), Rail (by geographic region), Shipping
6	Feedstock transport	Transport mode fuel efficiency	Truck (by geographic region), Rail (by geographic region), Shipping
6	Conversion (esterification)	Fuel emissions factor	Coal, Natural gas, Heavy fuel oil, Biomass
6	Conversion (esterification)	Energy configuration	Simple boiler, CHP unit
7	Liquid fuel transport	Transport mode fuel efficiency	Pipeline, Truck (by geographic region), Rail (by geographic region), Shipping

Default fuel chain

Stage 1 - Crop Production

Description	Cultivation and harvesting of soy						
Basic Data							
	Units						
Yield @ traded moisture content	[t/ha.a]	*value* Y					
Moisture content	%	*value* M1					
Soil Emissions							
				Emissions factor ($kgCO_2e/ha$)		Emissions ($kgCO_2e/t$ soy)	
N_2O emissions				*calculation N FERT x 6.613*	÷ Y =	*calculation*	1
		Mass of input		Emissions co-efficient [$kgCO_2e/k$ g nutrient]		Emissions ($kgCO_2e/t$ soy)	
N fertiliser	[kg N / ha.a]	*value* (N FERT)	x	*value*	÷ Y =	*calculation*	2
P fertiliser	[kg P_2O_5 / ha.a]	*value*	x	*value*	÷ Y =	*calculation*	3
K fertiliser	[kg K_2O / ha.a]	*value*	x	*value*	÷ Y =	*calculation*	4
				Emissions co-efficient [$kgCO_2e/k$ g]			
Pesticides	[kg/ha.a]	*value*	x	*value*	÷ Y =	*calculation*	5
				Emissions co-efficient [$kgCO_2e/kWh$]			
Electricity	[kWh/ha.a]	*value*	x	*value*	÷ Y =	*calculation*	6
Machinery Inputs							
Diesel fuel consumption	[litres/ha.a]	*value*	x	*value*	÷ Y =	*calculation*	7
Totals						Emissions ($kgCO_2e/t$ soy)	
Module total					1 + 2 + 3 + 4 + 5 + 6 + 7 =	*calculation*	8
						Emissions [$kgCO_2e/t$ biodiesel]	
Contribution to fuel chain					(8) ÷ Z1 ÷ Z2 x Allocation_1 x Allocation_2 =	*calculation*	Stage_1

Stage 2 - Drying and storage

Description	Drying of soy						
Basic Data							
Moisture removed	%	*value* M2					
Drying and storage inputs				Emissions factor ($kgCO_2e/MJ$)			
Natural gas	[MJ/t soy]	*value*	x	*value*	=	*calculation*	9
Electricity	[MJ/t soy]	*value*	x	*value*	=	*calculation*	10
Totals						Emissions ($kgCO_2e/t$ soy)	
Module total					9 + 10 =	*calculation*	11
						Emissions [$kgCO_2e/t$ biodiesel]	
Contribution to fuel chain					(11) ÷ Z1 ÷ Z2 x Allocation_1 x Allocation_2 =	*calculation*	Stage_2

Stage 3 - Feedstock Transport

Description	From drying and storage facility to oil extraction plant						
				Emissions factor (kgCO2e/MJ)			
Transport distance	[km]	*value*	dist_1				
Fuel consumption	[MJ/t-km]	*value*	FC_1				
Totals						Emissions ($kgCO_2e$/t soy)	
Module total	[MJ/t]	*calculation = dist_1 x FC_1*	x	*value*	=	*calculation*	12
						Emissions [$kgCO_2e$/t biodiesel]	
Contribution to fuel chain				(12) ÷ Z1 ÷ Z2 x Allocation_1 x Allocation_2 =		*calculation*	Stage_3

Stage 4 - Conversion

Description	Oil extraction						
Basic Data							
Plant yield	[t soy oil / t soy]	*value*	Z1				
Conversion Inputs				Emissions factor ($kgCO_2e$/MJ)		Emissions ($kgCO_2e$/t biodiesel)	
Natural gas	[MJ/t soy oil]	*value*	x	*value*	=	*calculation*	13
Electricity imported	[MJ/t soy oil]	*value*	x	*value*	=	*calculation*	14
Co-products							
Co-products treated by substitution				Credit [kg CO_2e/t co-product]			
Quantity of co-product 1	[t co-product 1 / t soy oil]	*value*	x	*value*	=	*calculation*	15
Quantity of co-product 2	[t co-product 2 / t soy oil]	*value*	x	*value*	=	*calculation*	16
Quantity of co-product 3	[t co-product 3 / t soy oil]	*value*	x	*value*	=	*calculation*	17
etc							
Co-products treated by allocation by market value							
Allocation factor - percentage of emissions attributable to soy oil	%					*calculation*	Allocation_1
Co-products treated by allocation by energy content							
Allocation factor - percentage of emissions attributable to soy oil	%					*calculation*	Allocation_1
Totals							
Module total				(13 + 14 + 15 + 16 + 17) x Allocation_1 =		*calculation*	18
						Emissions [$kgCO_2e$/t biodiesel]	
Contribution to fuel chain				(18) ÷ Z2 x Allocation_2 =		*calculation*	Stage_4

Stage 5 - Feedstock Transport

Description	From crusher to port (Mode 1)						
				Emissions factor ($kgCO_2e$/MJ)			
Transport distance	[km]	*value*	dist_2				
Fuel consumption	[MJ/t-km]	*value*	FC_2				
Totals						Emissions ($kgCO_2e$/t soy oil)	
Module total	[MJ/t soy oil]	*calculation = dist_2 x FC_2*	x	*value*	=	*calculation*	19
						Emissions [$kgCO_2e$/t biodiesel]	
Contribution to fuel chain				(19) ÷ Z2 x Allocation_2 =		*calculation*	Stage_5

Stage 6 - Feedstock Transport

Description	From port to biodiesel plant (Mode 2)							
					Emissions factor ($kgCO_2e/MJ$)			
Transport distance	[km]	*value*	dist_3					
Fuel consumption	[MJ/t-km]	*value*	FC_3					
Totals							Emissions ($kgCO_2e/t$ soy oil)	
Module total	[MJ/t soy oil]	*calculation = dist_3 x FC_3*		x	*value*	=	*calculation*	20
							Emissions [$kgCO_2e/t$ biodiesel]	
Contribution to fuel chain						(20) ÷ Z2 x Allocation_2 =	*calculation*	Stage_6

Stage 7 - Conversion

Description	Biodiesel plant							
Basic data								
Plant yield	[t biodiesel / t soy oil]	*value*	Z2					
Conversion Inputs					Emissions factor ($kgCO_2e/MJ$)		Emissions ($kgCO_2e/t$ ethanol)	
Natural gas	[MJ/t biodiesel]	*value*		x	*value*	=	*calculation*	21
Electricity imported	[MJ/t biodiesel]	*value*		x	*value*	=	*calculation*	22
					Emissions factor ($kgCO_2e/k$ g)			
Methanol	kg/t biodiesel	*value*		x	*value*	=	*calculation*	23
Potassium hydroxide	kg/t biodiesel	*value*		x	*value*	=	*calculation*	24
Co-products								
Co-products treated by substitution					Credit [kg CO_2e/t co-product]			
Quantity of co-product 1	[t co-product 1 / t biodiesel]	*value*		x	*value*	=	*calculation*	25
Quantity of co-product 2	[t co-product 2 / t biodiesel]	*value*		x	*value*	=	*calculation*	26
Quantity of co-product 3	[t co-product 3 / t biodiesel]	*value*		x	*value*	=	*calculation*	27
etc								
Co-products treated by allocation by market value								
Allocation factor - percentage of emissions attributable to biodiesel	%						*calculation*	Allocation_2
Co-products treated by allocation by energy content								
Allocation factor - percentage of emissions attributable to biodiesel	%						*calculation*	Allocation_2
Totals							Emissions [$kgCO_2e/t$ biodiesel]	
Module total						(21 + 22 + 23 + 24 + 25 + 26 + 27) x Allocation_2 =	*calculation*	28
Contribution to fuel chain						28 =	*calculation*	Stage_7

Stage 8 - Liquid fuel transport and storage

Description	From biodiesel plant to refinery / blending facility							
Transport distance	[km]	*value*	dist_4					
Fuel consumption	[MJ/t-km]	*value*	FC_4					
Totals					Emissions factor ($kgCO_2e/MJ$)		Emissions [$kgCO_2e/t$ biodiesel]	
Module total	[MJ/t biodiesel]	*calculation = dist_4 x FC_4*		x	*value*	=	*calculation*	29
Contribution to fuel chain						29 =	*calculation*	Stage_8

Default value tables

Stage/Input	Units	Feedstock country of origin		
		Argentina	Brazil	USA
Stage 1 – Crop Production				
Yield @ traded moisture content	[t/ha.a]	2.5	2.5	2.6
Moisture content	%	13	13	13
N2O emissions from soils	[kgCO_2e/ha.a]	62	62	145
N fertiliser	[kg N/ha.a]	10	10	24
Type of N fertiliser		Urea	Urea	AN
P fertiliser	[kg P_2O_5/ha.a]	5	50	100
Type of P fertiliser		MAP	MAP	TSP
K fertiliser	[kg/ha.a]	3	60	55
Pesticides	[kg/ha.a]	1.31	1.31	1.31
Electricity	[kWh/ha.a]	11.37	11.37	11.37
Diesel fuel consumption	[litres/ha.a]	75.6	75.6	75.6
Stage 2 – Drying and storage				
Moisture removed	%	2	2	2
Natural gas	[MJ/t soy]	0	0	467
Diesel	[MJ/t soy]	467	467	467
Electricity	[MJ/t soy]	31	31	31
Stage 3 – Feedstock Transport				
Transport distance	[km]	330	1500	100
Fuel consumption	[MJ/t-km]	1.8	1.8	1.46
Stage 4 – Conversion				
Yield	[t soy oil/t soy]	0.17	0.17	0.17
Natural gas	[MJ/t soy oil]	5447	5447	5447
Electricity imported	[MJ/t soy oil]	1476	1476	1476
Co-products	Description	Treatment		
Co-product 1:	Soymeal sold as animal feed	Substitutes for EU wheat		
Quantity of soy meal produced & sold as animal feed	[t soy meal/t soy oil]	4.3	4.3	4.3

Stage/Input	Units	Feedstock country of origin		
		Argentina	Brazil	USA
Credit	[kgCO_2e/t soy meal]	-412	-412	-412
Stage 5 – Feedstock Transport				
Transport distance	[km]	0	0	1500
Fuel consumption	[MJ/t-km]	0	0	0.19
Stage 6 – Feedstock Transport				
Transport distance	[km]	13000	10000	7000
Fuel consumption	[MJ/t-km]	0.2	0.2	0.2
Stage 7 – Conversion				
Yield	[t biodiesel/t soy oil]	0.95	0.95	0.95
Natural gas	[MJ/t biodiesel]	1690	1690	1690
Electricity imported	[MJ/t biodiesel]	335	335	335
Methanol	kg/t biodiesel	113	113	113
Potassium hydroxide	kg/t biodiesel	26	26	26
Co-products				
Co-product 1	Crude glycerine	Allocation by market value		
Quantity of crude glycerine	[t glycerine/t biodiesel]	0.1	0.1	0.1
Market value of glycerine	[£/t glycerine]	0	0	0
Co-product 2:	Potassium sulphate	Allocation by market value		
Quantity of potassium sulphate	[t potassium sulphate/t biodiesel]	0.04	0.04	0.04
Market value of potassium sulphate	[£/t potassium sulphate]	75	75	75
Primary product: biodiesel				
Market value of biodiesel	[£/t biodiesel]	340	340	340
Allocation factor	%	99	99	99
Stage 8 – Liquid fuel transport and storage				
Transport distance	[km]	0	0	0
Fuel consumption	[MJ/t-km]	0	0	0

Palm to biodiesel

Fuel chain summary

	Carbon intensity [kg CO_2/t biodiesel]	
	Indonesia	Malaysia
1 – Crop Production	278	297
2 – Feedstock transport	63	67
3 – Conversion (palm oil extraction)	573	573
4 – Feedstock transport	72	45
5 – Conversion (palm oil refining)	129	120
6 – Feedstock transport	273	273
7 – Conversion (esterification)	519	519
8 – Liquid fuel transport	0	0
TOTAL	**1907**	**1893**

Selected default options

Stage	Module	Input	Options
1	Crop production	Nitrogen fertiliser emissions factor	Ammonium nitrate, Sulphate of ammonia, Urea
1	Crop production	Phosphorus fertiliser emissions factor	Triple super-phosphate, Rock phosphate
2	Feedstock transport	Transport mode fuel efficiency	Truck (by geographic region), Rail (by geographic region), Shipping
4	Feedstock transport	Transport mode fuel efficiency	Truck (by geographic region), Rail (by geographic region), Shipping
5	Conversion (palm oil refining)	Fuel emissions factor	Coal, Natural gas, Heavy fuel oil, Biomass
5	Conversion (palm oil refining)	Energy configuration	Simple boiler, CHP unit

Stage	Module	Input	Options
6	Feedstock transport	Transport mode fuel efficiency	Truck (by geographic region), Rail (by geographic region), Shipping
7	Conversion (esterification)	Fuel emissions factor	Coal, Natural gas, Heavy fuel oil, Biomass
7	Conversion (esterification)	Energy configuration	Simple boiler, CHP unit
8	Liquid fuel transport	Transport mode fuel efficiency	Pipeline, Truck (by geographic region), Rail (by geographic region), Shipping

Default fuel chain

Stage 1 - Crop Production

Description	Cultivation and harvest of Fresh Fruit Bunches (FFB)						
Basic Data							
Yield of FFB	Units [t/ha.a]	*value*	Y				
Soil Emissions							
				Emissions factor ($kgCO_2e/ha$)		Emissions ($kgCO_2e/t$ FFB)	
N_2O emissions				*calculation* *N FERT x 6.613*	÷ Y =	*calculation*	1
Farming Inputs							
		Mass of input		Emissions co-efficient [$kgCO_2e/kg$ nutrient]		Emissions ($kgCO_2e/t$ FFB)	
N fertiliser	[kg N / ha.a]	*value* (N FERT)	x	*value*	÷ Y =	*calculation*	2
P fertiliser	[kg P_2O_5 / ha.a]	*value*	x	*value*	÷ Y =	*calculation*	3
K fertiliser	[kg K_2O / ha.a]	*value*	x	*value*	÷ Y =	*calculation*	4
Mg fertiliser	[kg Mg / ha.a]	*value*	x	*value*	÷ Y =	*calculation*	5
NPK fertiliser	[kg N / ha.a]	*value*	x	*value*	÷ Y =	*calculation*	6
				Emissions co-efficient [$kgCO_2e/kg$]			
Pesticide	[kg/ha.a]	*value*	x	*value*	÷ Y =	*calculation*	7
Machinery and transport Inputs							
				Emissions factor ($kgCO_2e/l$)		Emissions ($kgCO_2e/t$ FFB)	
Nursey & plantation establishment	[litres/ha.a]	*value*	x	*value*	÷ Y ÷ 25 =	*calculation*	8
Harvest and collection	[litres/ha.a]	*value*	x	*value*	÷ Y =	*calculation*	9
Totals						Emissions ($kgCO_2e/t$ FFB)	
Module total					1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 =	*calculation*	10
						Emissions [$kgCO_2e/t$ biodiesel]	
Contribution to fuel chain					(10) ÷ Z1 ÷ Z2 ÷ Z3 x Allocation_1 x Allocation_2 x Allocation_3 =	*calculation*	Stage_1

Stage 2 - Feedstock Transport

Description	Transport of FFB from field to palm oil mill						
				Emissions factor ($kgCO_2e/MJ$)			
Transport distance	[km]	*value*	dist_1				
Fuel consumption	[MJ/t-km]	*value*	FC_1				
Totals						Emissions ($kgCO_2e/t$ FFB)	
Module total	[MJ/t FFB]	*calculation* *= dist 1 x FC 1*	x	*value*	=	*calculation*	11
						Emissions [$kgCO_2e/t$ biodiesel]	
Contribution to fuel chain					(11) ÷ Z1 ÷ Z2 ÷ Z3 x Allocation_1 x Allocation_2 x Allocation_3 =	*calculation*	Stage_2

Stage 3 - Conversion

Description	Processing FFB to extract crude palm oil (CPO) and palm kernels							
Basic Data								
Palm oil mill yield	[t CPO / t FFB]	*value*	Z1					
Extraction Inputs					Emissions factor ($kgCO_2e/MJ$)		Emissions ($kgCO_2e/t$ CPO)	
Fibre & Shell, CHP plant	[MJ/t CPO]	*value*		x	*value*	=	*calculation*	12
Mill effluent emissions (POME)	[kg/t CPO]	*value*		x	*value*	=	*calculation*	13
Co-products								
Co-products treated by substitution					Credit [kg CO_2e/t co-product]			
Quantity of co-product 1	[t co-product 1 / t CPO]	*value*		x	*value*	=	*calculation*	14
Quantity of co-product 2	[t co-product 2 / t CPO]	*value*		x	*value*	=	*calculation*	15
Quantity of co-product 3	[t co-product 3 / t CPO]	*value*		x	*value*	=	*calculation*	16
etc								
Co-products treated by allocation by market value								
Allocation factor - percentage of emissions attributable to CPO	%						*calculation*	Allocation_1
Co-products treated by allocation by energy content								
Allocation factor - percentage of emissions attributable to CPO	%						*calculation*	Allocation_1
Totals							Emissions ($kgCO_2e/t$ CPO)	
Module total					(12 + 13 + 14 + 15 + 16) x Allocation_1 =		*calculation*	17
							Emissions [$kgCO_2e/t$ biodiesel]	
Contribution to fuel chain					(17) ÷ Z2 ÷ Z3 x Allocation_2 x Allocation_3 =		*calculation*	Stage_3

Stage 4 - Feedstock Transport

Description	Transport of CPO from palm oil mill to refinery							
					Emissions factor ($kgCO_2e/MJ$)			
Transport distance	[km]	*value*	dist_2					
Fuel consumption	[MJ/t-km]	*value*	FC_2					
Totals							Emissions ($kgCO_2e/t$ CPO)	
Module total	[MJ/t CPO]	*calculation = dist_2 x FC_2*		x	*value*	=	*calculation*	18
							Emissions [$kgCO_2e/t$ biodiesel]	
Contribution to fuel chain					(18) ÷ Z2 ÷ Z3 x Allocation_2 x Allocation_3 =		*calculation*	Stage_4

Stage 5 - Conversion

Description	Refining, bleaching and deodorising of CPO, and fractionation to produce palm olein							
Basic Data								
Refinery yield	[t palm olein / t CPO]	*value*	Z2					
Conversion Inputs					Emissions factor ($kgCO_2e/MJ$)		Emissions ($kgCO_2e/t$ ethanol)	
Natural gas	[MJ/t palm olein]	*value*		x	*value*	=	*calculation*	19
Electricity imported	[MJ/t palm olein]	*value*		x	*value*	=	*calculation*	20
Co-products								
Co-products treated by substitution					Credit [kg CO_2e/t co-product]			
Quantity of co-product 1	[t co-product 1 / t palm olein]	*value*		x	*value*	=	*calculation*	21
Quantity of co-product 2	[t co-product 2 / t palm olein]	*value*		x	*value*	=	*calculation*	22
Quantity of co-product 3	[t co-product 3 / t palm olein]	*value*		x	*value*	=	*calculation*	23
etc								
Co-products treated by allocation by market value								
Allocation factor - percentage of emissions attributable to palm olein	%						*calculation*	Allocation_2
Co-products treated by allocation by energy content								
Allocation factor - percentage of emissions attributable to palm olein	%						*calculation*	Allocation_2
Totals							Emissions ($kgCO_2e/t$ palm olein)	
Module total					(19 + 20 + 21 + 22 + 23) x Allocation_2 =		*calculation*	24
							Emissions [$kgCO_2\,e/t$ biodiesel]	
Contribution to fuel chain					(24) ÷ Z3 x Allocation_3 =		*calculation*	Stage_5

Stage 6 - Feedstock Transport

Description	Transport of palm olein from refinery to biodiesel plant							
					Emissions factor ($kgCO_2e/MJ$)			
Transport distance	[km]	*value*	dist_3					
Fuel consumption	[MJ/t-km]	*value*	FC_3					
Totals							Emissions ($kgCO_2e/t$ palm olein)	
Module total	[MJ/t palm olein]	*calculation = dist_3 x FC_3*		x	*value*	=	*calculation*	25
							Emissions [$kgCO_2e/t$ biodiesel]	
Contribution to fuel chain					(25) ÷ Z3 x Allocation_3 =		*calculation*	Stage_6

Stage 7 - Conversion

Description	Biodiesel plant							
Basic data								
Biodiesel plant yield	[t biodiesel / t palm olein]	*value*	Z3					
Conversion Inputs				Emissions factor ($kgCO_2e/MJ$)		Emissions ($kgCO_2e/t$ biodiesel)		
Natural gas	[MJ/t biodiesel]	*value*	x	*value*	=	*calculation*	26
Electricity imported	[MJ/t biodiesel]	*value*	x	*value*	=	*calculation*	27
				Emissions factor ($kgCO_2e/kg$)			
Methanol	kg/t biodiesel	*value*	x	*value*	=	*calculation*	28
Potassium hydroxide	kg/t biodiesel	*value*	x	*value*	=	*calculation*	29
Co-products							
Co-products treated by substitution				Credit [kg CO_2e/t co-product]			
Quantity of co-product 1	[t co-product 1 / t biodiesel]	*value*	x	*value*	=	*calculation*	30
Quantity of co-product 2	[t co-product 2 / t biodiesel]	*value*	x	*value*	=	*calculation*	31
Quantity of co-product 3	[t co-product 3 / t biodiesel]	*value*	x	*value*	=	*calculation*	32
etc							
Co-products treated by allocation by market value							
Allocation factor - percentage of emissions attributable to biodiesel	%					*calculation*	Allocation_3
Co-products treated by allocation by energy content							
Allocation factor - percentage of emissions attributable to biodiesel	%					*calculation*	Allocation_3
Totals						Emissions [$kgCO_2$ e/t biodiesel]	
Module total			(26 + 27 + 28 + 29 + 30 + 31 + 32) x Allocation_3 =			*calculation*	33
Contribution to fuel chain					33 =	*calculation*	Stage_7

Stage 8 - Liquid fuel transport and storage

Description	Transport from biodiesel plant to refinery / blending facility						
Transport distance	[km]	*value*	dist_4				
Fuel consumption	[MJ/t-km]	*value*	FC_4				
Totals						Emissions [$kgCO_2e/t$ biodiesel]	
Module total	[MJ/t biodiesel]	*calculation = dist_4 x FC_4*	x	*value*	=	*calculation*	34
Contribution to fuel chain					34 =	*calculation*	Stage_8

Default value tables

Stage/Input	Units	Feedstock country of origin	
		Malaysia	Indonesia
Stage 1 – Crop Production			
Yield of FFB	[t/ha.a]	19	18
N2O emissions from soils	[kgCO_2e/ha.a]	616	585
N fertiliser	[kg N/ha.a]	100	95
Type of N fertiliser		SOA	SOA
P fertiliser	[kg/ha.a]	45	30
Type of P fertiliser		Rock	Rock
K fertiliser	[kg/ha.a]	205	75
Mg fertiliser (MgO)	[kg/ha.a]	33	33
NPK fertiliser	[kg/ha.a]	50	50
Pesticide	[kg/ha.a]	3	3
Nursery & plantation establishment	[litres/ha.a]	30	30
Harvest and collection	[litres/ha.a]	40	40
Stage 2 – Feedstock Transport			
Transport distance	[km]	17	17
Fuel consumption	[MJ/t-km]	1.8	1.8
Stage 3 – Conversion			
Palm oil mill yield	[t CPO/t FFB]	0.2	0.2
Fibre & Shell in CHP plant	[MJ/t CPO]	9463	9463
Mill effluent emissions (POME)	[kg/t CPO]	2500	2500
Co-products	Description	Treatment	
Co-product 1	Palm kernel	Allocation by market value	
Quantity of palm kernel	[t palm kernel/t CPO]	0.3	0.3
Market value of palm kernel	[RM/t palm kernel]	992	992
Primary product: CPO			
Market value of CPO	[RM/t palm olein]	1525	1524
Allocation factor	%	84	84

Stage/Input	Units	Feedstock country of origin	
		Malaysia	Indonesia
Stage 4 – Feedstock Transport			
Transport distance	[km]	250	400
Fuel consumption	[MJ/t-km]	1.89	1.89
Stage 5 – Conversion			
Refinery yield	[t palm olein/t CPO]	0.8	0.8
Natural gas	[MJ/t palm olein]	1365	1365
Electricity imported	[MJ/t palm olein]	121	121
Co-products	Description	Treatment	
Co-product 1	Palm stearin	Allocation by market value	
Quantity of palm stearin	[t palm stearin/t palm olein]	0.2	0.2
Market value of palm stearin	[USD/t palm stearin]	389	389
Primary product: palm olein			
Market value of palm olein	[USD/t palm olein]	438	438
Allocation factor	%	85	85
Stage 6 – Feedstock Transport			
Transport distance	[km]	15000	15000
Fuel consumption	[MJ/t-km]	0.2	0.2
Stage 7 – Conversion			
Biodiesel Yield	[t biodiesel/t palm olein]	0.95	0.95
Natural gas	[MJ/t biodiesel]	1690	1690
Electricity imported	[MJ/t biodiesel]	335	335
Methanol	kg/t biodiesel	113	113
Potassium hydroxide	kg/t biodiesel	26	26
Co-products			
Co-product 1	Crude glycerine	Allocation by market value	
Quantity of crude glycerine	[t glycerine/t biodiesel]	0.1	0.1
Market value of glycerine	[£/t glycerine]	0	0

Stage/Input	**Units**	**Feedstock country of origin**	
		Malaysia	**Indonesia**
Co-product 2:	Potassium sulphate	Allocation by market value	
Quantity of potassium sulphate	[t potassium sulphate/t biodiesel]	0.04	0.04
Market value of potassium sulphate	[£/t potassium sulphate]	75	75
Primary product: biodiesel			
Market value of biodiesel	[£/t biodiesel]	340	340
Allocation factor	%	99	99
Stage 8 – Liquid fuel transport and storage			
Transport distance	[km]	0	0
Fuel consumption	[MJ/t-km]	0	0

Used cooking oil and tallow to biodiesel

Fuel chain summary

	Carbon intensity [kg CO_2/t biodiesel]
1 – Feedstock Transport	8
2 – Conversion	519
3 – Liquid fuel transport	0
TOTAL	526

Selected default options

Stage	Module	Input	Options
1	Feedstock transport	Transport mode fuel efficiency	Truck (by geographic region), Rail (by geographic region), Shipping
2	Conversion	Fuel emissions factor	Coal, Natural gas, Heavy fuel oil, Biomass
2	Conversion	Energy configuration	Simple boiler, CHP unit
3	Liquid fuel transport	Transport mode fuel efficiency	Pipeline, Truck (by geographic region), Rail (by geographic region), Shipping

Default fuel chain

Stage 1 - Feedstock Transport

Description	From central aggregation point to biodiesel plant. Note - includes credit for alternative waste treatment						
Alternative waste treatment						Emissions ($kgCO_2e$/t feedstock)	
Credit	[kg CO_2e/t feedstock]	*value*	x	*value*	=	*calculation*	1
Transport							
Transport distance	[km]	*value*	dist_1				
Fuel consumption	[MJ/t-km]	*value*	FC_1				
Totals				Emissions factor ($kgCO_2e$/MJ)		Emissions ($kgCO_2e$/t feedstock)	
Module total	[MJ/t feedstock]	*calculation = dist_1 x FC_1*	x	*value*	=	*calculation*	2
						Emissions [$kgCO_2e$/t biodiesel]	
Contribution to fuel chain				(1 + 2) ÷ Z x Allocation_1	=	*calculation*	Stage_1

Stage 2 - Conversion

Description	Biodiesel plant							
Basic data								
Plant yield	[t biodiesel / t UCO or tallow]	*value*	Z					
Conversion Inputs					Emissions factor ($kgCO_2e/MJ$)		Emissions ($kgCO_2e/t$ biodiesel)	
Natural gas	[MJ/t biodiesel]	*value*		x	*value*	=	*calculation*	3
Electricity imported	[MJ/t biodiesel]	*value*		x	*value*	=	*calculation*	4
					Emissions factor ($kgCO_2e/kg$)			
Methanol	kg/t biodiesel	*value*		x	*value*	=	*calculation*	5
Potassium hydroxide	kg/t biodiesel	*value*		x	*value*	=	*calculation*	6
Co-products								
Co-products treated by substitution					Credit [kg CO_2e/t co-product]			
Quantity of co-product 1	[t co-product 1 / t biodiesel]	*value*		x	*value*	=	*calculation*	7
Quantity of co-product 2	[t co-product 2 / t biodiesel]	*value*		x	*value*	=	*calculation*	8
Quantity of co-product 3	[t co-product 3 / t biodiesel]	*value*		x	*value*	=	*calculation*	9
etc								
Co-products treated by allocation by market value								
Allocation factor - percentage of emissions attributable to biodiesel	%						*calculation*	Allocation_1
Co-products treated by allocation by energy content								
Allocation factor - percentage of emissions attributable to biodiesel	%						*calculation*	Allocation_1
Totals							Emissions [$kgCO_2e/t$ biodiesel]	
Module total						(3 + 4 + 5 + 6 + 7 + 8 + 9) x Allocation_1 =	*calculation*	10
Contribution to fuel chain						10 =	*calculation*	Stage_2

Stage 3 - Liquid fuel transport and storage

Description	From biodiesel plant to refinery / blending facility							
Transport distance	[km]	*value*	dist_2					
Fuel consumption	[MJ/t-km]	*value*	FC_2					
Totals					Emissions factor ($kgCO_2e/MJ$)		Emissions [$kgCO_2e/t$ biodiesel]	
Module total	[MJ/t biodiesel]	*calculation = dist_2 x FC_2*		x	*value*	=	*calculation*	11
Contribution to fuel chain						11 =	*calculation*	Stage_3

Default value tables

Stage/Input	Units	Value
Stage 1 – Feedstock Transport		
Credit for alternative waste treatment	[kg CO_2e/t feedstock]	0
Transport distance	[km]	50
Fuel consumption	[MJ/t-km]	1.53
Stage 2 – Conversion		
Yield	[t biodiesel/t UCO or tallow]	0.875
Natural gas	[MJ/t biodiesel]	1690
Electricity imported	[MJ/t biodiesel]	335
Methanol	kg/t biodiesel	113
Potassium hydroxide	kg/t biodiesel	26
Co-product 1	Crude glycerine	Allocation by market value
Quantity of crude glycerine	[t glycerine/t biodiesel]	0.1
Market value of glycerine	[£/t glycerine]	0
Co-product 2:	Potassium sulphate	Allocation by market value
Quantity of potassium sulphate	[t potassium sulphate/t biodiesel]	0.04
Market value of potassium sulphate	[£/t potassium sulphate]	75
Primary product: biodiesel		
Market value of biodiesel	[£/t biodiesel]	340
Allocation factor	%	99
Stage 3 – Liquid fuel transport and storage		
Transport distance	[km]	0
Fuel consumption	[MJ/t-km]	0

Ethanol to ETBE

ETBE can be produced in two ways:

- Using isobutene in a refinery, in which case it is most likely to be substituting MTBE from the fuel mix, or
- Using isobutene imported from a dedicated isobutene plant, in which case it is most likely to be substitution gasoline from the fuel mix.

In the first case, the benefits of substituting MTBE (which is more carbon intensive than gasoline) from the fuel mix must be taken into account. Fuel suppliers who are able to prove that refinery by-product isobutene has been used in the production of ETBE will be able to report default values which specifically take this into account. Consequently, there are two sets of default values and two different fuel chains within this section.

Fuel chain summary

ETBE produced using refinery by-product isobutene

	Carbon intensity [kg CO_2/MJ ETBE]							
Feedstock	Wheat				Sugar beet	Sugar cane	Corn	
Origin	Canada	France	Germany	United Kingdom	UK	Brazil	US	France
1 – Conversion	871	593	506	525	171	-238	1089	318
2 – Liquid fuel transport & storage	8	8	8	8	8	8	8	8
TOTAL	**879**	**600**	**514**	**533**	**179**	**-230**	**1097**	**326**

ETBE produced using isobutene from a dedicated plant

	Carbon intensity [kg CO_2/MJ ETBE]							
Feedstock	Wheat				Sugar beet	Sugar cane	Corn	
Origin	Canada	France	Germany	United Kingdom	UK	Brazil	US	France
1 – Conversion	1792	1513	1427	1446	1092	682	1238	2010
2 – Liquid fuel transport & storage	8	8	8	8	8	8	8	8
TOTAL	**1800**	**1521**	**1435**	**1454**	**1100**	**690**	**1246**	**2018**

Selected default options (for both fuel chains)

Stage	Module	Input	Options
1	Conversion	Fuel emissions factor	Coal, Natural gas, Heavy fuel oil, Biomass
1	Conversion	Energy configuration	Simple boiler, CHP unit
2	Liquid fuel transport	Transport mode fuel efficiency	Pipeline, Truck (by geographic region), Rail (by geographic region), Shipping

Default fuel chain: ETBE produced using refinery by-product isobutene

Stage 1 - Conversion

Description	ETBE conversion facility						
When isobutene is taken from a refinery, it is assumed it would have otherwise been used to produce MTBE. It is assumed that producing ETBE requires no marginal increase in natural gas, electricity or isobutene - aee Methodology document for a full explanation							
Inputs				Ethanol carbon intensity [kg CO_2e / t ethanol]			
Ethanol	[t ethanol / t ETBE]	*value*	x	*value*	=	*calculation*	1
Credit for avoided methanol (minus additional gasoline required)						Emissions (kgCO_2e/t ETBE)	
Credit	g CO_2 / t ETBE					*calculation*	2
Totals						Emissions (kgCO_2e/t ETBE)	
Module total					1 + 2 + 3 =	*calculation*	3
Contribution to fuel chain					3 =	*calculation*	Stage_1

Stage 2 - Liquid fuel transport and storage

Description	From ETBE conversion facitity to duty point						
Transport distance	[km]	*value*	dist_1				
Fuel consumption	[MJ/t-km]	*value*	FC_1				
Totals				Emissions factor (kgCO_2e/MJ)		Emissions (kgCO_2e/t ETBE)	
Module total	[MJ/t ETBE]	*calculation = dist_1 x FC_1*	x	*value*	=	*calculation*	4
Contribution to fuel chain					4 =	*calculation*	Stage_2

Default fuel chains: ETBE produced using isobutene from in a dedicated plant

Stage 1 - Conversion

Description	ETBE conversion facility						
Inputs				Ethanol carbon intensity [kg CO_2e / t ethanol]			
Ethanol	[t ethanol / t ETBE]	*value*	x	*value*	=	*calculation*	1
Conversion Inputs				Emissions factor (kgCO_2e/MJ)		Emissions (kgCO_2e/t ethanol)	
Natural gas	[MJ/t ETBE]	*value*	x	*value*	=	*calculation*	2
Electricity imported	[MJ/t ETBE]	*value*	x	*value*	=	*calculation*	3
				Emissions factor (kgCO_2e/kg)			
Isobutene	[kg / t ETBE]	*value*	x	*value*	=	*calculation*	4
Totals						Emissions (kgCO_2e/t ETBE)	
Module total					1 + 2 + 3 + 4 =	*calculation*	5
Contribution to fuel chain					5 =	*calculation*	Stage_1

Stage 2 - Liquid fuel transport and storage							
Description	From ETBE conversion facitity to duty point						
Transport distance	[km]	*value*	dist_1				
Fuel consumption	[MJ/t-km]	*value*	FC_1				
Totals				Emissions factor ($kgCO_2e/MJ$)		Emissions ($kgCO_2e/t$ ETBE)	
Module total	[MJ/t ETBE]	*calculation = dist_1 x FC_1*	x	*value*	=	*calculation*	6
Contribution to fuel chain					6 =	*calculation*	Stage_2

Default value tables (for both fuel chains)

Stage/Input	**Units**	**Refinery isobutene**	**Imported isobutene**
Stage 1 – Conversion			
Ethanol	[t ethanol/t ETBE]	0.493	0.493
Natural gas	[MJ/t ETBE]	0	2265
Electricity imported	[MJ/t ETBE]	0	145
Isobutene	[kg/t ETBE]	0	507
Credit	[$kgCO_2e/t$ ETBE]	-508	0
Stage 2 – Liquid fuel transport and storage			
Transport distance	[km]	400	400
Fuel consumption	[MJ/t-km]	0.2	0.2

Manure and organic solid waste to biomethane

Fuel chain summary

	Carbon intensity [kg CO_2/MJ biomethane]
1 – Feedstock transport	0.006
2 – Conversion	0.030
3 – Gaseous fuel transport and storage	0.000
Total	0.036

Selected default options

Stage	Module	Input	Options
1	Feedstock transport	Transport mode fuel efficiency	Truck (by geographic region), Rail (by geographic region), Shipping
2	Conversion	Fuel emissions factor	Coal, Natural gas, Heavy fuel oil, Biomass
2	Conversion	Energy configuration	Simple boiler, CHP unit

Default fuel chain

Stage 1 - Feedstock Transport

Description	From central aggregation point to digestion plant							
Alternative waste treatment							Emissions ($kgCO_2e$/t feedstock)	
Credit	[kg CO_2e/t feedstock]	*value*	x	*value*	=		*calculation*	1
Transport								
Transport distance	[km]	*value*	dist_1					
Fuel consumption	[MJ/t-km]	*value*	FC_1					
Totals				Emissions factor ($kgCO_2e$/MJ)			Emissions ($kgCO_2e$/t feedstock)	
Module total	[MJ/t feedstock]	*calculation = dist_1 x FC_1*	x	*value*	=		*calculation*	2
							Emissions ($kgCO_2e$/MJ biomethane)	
Contribution to fuel chain						(1 + 2) ÷ Z =	*calculation*	Stage_1

Stage 2 - Conversion

Description	Digestion plant							
Plant yield	MJ biomethane / t waste	*value*	Z					
Basic data								
Mix of feedstock								
Wet manure	%	*value*	WM					
Dry manure	%	*value*	DM					
OSW	%	*value*	OSW					
Conversion Inputs				Emissions factor ($kgCO_2e$/MJ)			Emissions ($kgCO_2e$/MJ biomethane)	
Natural gas (import)	MJ / MJ biomethane	*value*	x	*value*	=		*calculation*	3
Electricity (import)	MJ / MJ biomethane	*value*	x	*value*	=		*calculation*	4
				Emissions factor ($kgCO_2e/kgCH_4$)				
Methane losses	kg CH_4 lost / MJ biomethane	*value*	x	**23**	=		*calculation*	5
Co-products								
Co-products treated by substitution				Credit [kg CO_2e/t co-product]				
Quantity of co-product 1	[t co-product 1 / MJ biomethane]	*value*	x	*value*	=		*calculation*	6
Quantity of co-product 2	[t co-product 2 / MJ biomethane]	*value*	x	*value*	=		*calculation*	7
Quantity of co-product 3	[t co-product 3 / MJ biomethane]	*value*	x	*value*	=		*calculation*	8
etc								
Co-products treated by allocation by market value								
Allocation factor - percentage of emissions attributable to biomethane	%						*calculation*	Allocation_1
Co-products treated by allocation by energy content								
Allocation factor - percentage of emissions attributable to biomethane	%						*calculation*	Allocation_1
Totals							Emissions ($kgCO_2e$/MJ biomethane)	
Module total						3 + 4 + 5 + 6 + 7 + 8 =	*calculation*	9
Contribution to fuel chain						9 =	*calculation*	Stage_2

Stage 3 - Gas fuel transport and storage

Description	From biomethane plant to duty point							
Transport distance	[km]	*value*	dist_2					
Fuel consumption	[MJ/t-km]	*value*	FC_2					
Totals					Emissions factor ($kgCO_2e/MJ$)		Emissions ($kgCO_2e/MJ$ biomethane)	
Module total	[MJ/MJ]	*calculation = dist_2 x FC_2*		x	*value*	=	*calculation*	10
Contribution to fuel chain						10 =	*calculation*	Stage_3

Default value tables

Stage/Input	Units	Value
Stage 1 – Feedstock Transport		
Credit	[kg CO_2e/t feedstock]	0
Transport distance	[km]	40
Fuel consumption	[MJ/t-km]	8
Stage 2 – Conversion		
Yield	MJ biomethane/t waste	4298
Wet manure	%	40
Dry manure	%	40
OSW	%	20
Natural gas (import)	MJ/MJ biomethane	0
Electricity (import)	MJ/MJ biomethane	0.077
Methane losses	kg CH4 lost/MJ biomethane	0.0009
Co-products	Description	Treatment
Co-product 1	Organic nitrogen fertiliser	Substitutes synthetic N fertiliser
Fertiliser	MJ N/MJ biomethane	0.02318
Credit	kgCO_2e/MJ N	-0.03
Stage 3 – Gas fuel transport and storage		
Transport distance	[km]	0.36
Fuel consumption	[MJ/t-km]	0